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Late Archean decoupling of upper and mid crustal tectonothermal domains in the southeast Slave Province: evidence from the Walmsley Lake area.

By

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Abstract

The Walmsley Lake area of the southeastern Slave Province, NWT, exposes a continuous inclined crustal transect from greenschist through to amphibolite facies metamorphic grade. Two tectonothermal crustal domains are proposed based on disparate tectonic histories and lithologies. Within the upper tectonothermal domain, D_1 deformation reached lower-amphibolite facies prior to 2614 Ma, and associated M_1 metamorphic conditions outlasted D_1. Peak M_2 conditions reached middle-amphibolite facies prior to 2603 Ma, and outlasted D_2 deformation. Deformation style and metamorphic sequencing during these two pre-2600 Ma events are consistent with regional crustal shortening and thickening in the upper tectonothermal domain.

At mid-crustal levels in the lower tectonothermal domain, a third event (D_3-M_3) produced uppermost amphibolite facies metamorphic conditions, transposed pre-existing fabrics to shallow dips and produced sub-horizontal fabrics at ca. 2583 Ma. Exhumation of these mid-crustal rocks was accomplished by the orogenic collapse of a thermally weakened, over-thickened, crustal welt.

Preface

Candidates Statement

A version of this thesis has been submitted for publication to the Canadian Journal of Earth Sciences with co-authors C. Relf, K. MacLachlan, and W. Davis.

The Walmsley Lake mapping project comprised a three year, multi-government regional bedrock mapping effort. I worked with this program in the capacity of a senior geological assistant, and as a project leader. In this capacity I prepared, and am lead author on, preliminary and final geological maps for the project. As well I contributed to several interim articles on the geology of the area.

With respect to this thesis, I prepared and authored, with revisions from co-authors, the sections titled: Petrogenetic Constraints on P-T Conditions, Constraints on Pressure – Temperature – Time Paths, Quantitative Thermobarometry, and the Discussion. These sections are based on my field notes, petrology, and microprobe data. Tom Chacko kindly provided cordierite microprobe data for sample 2133 on very short notice.

I prepared and co-authored, sections titled “Introduction and Regional Setting” and “Geology of the Walmsley Lake Area”, with considerable input from co-authors Relf and MacLachlan.

I did **not** carry out the research, prepare, or author the section entitled U-Pb geochronology. Bill Davis and Kate MacLachlan, Geological Survey of Canada, carried out this work.

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Introduction and Regional Geological Setting

Much work has been done recently to constrain the tectonic evolution of the Slave Province. Several models exist describing the history of the Slave province as a product of; continental rifting and basin closure (Henderson, 1981; Fyson and Helmstaedt 1988; MacLachlan and Helmstaedt 1995), accretion of numerous arc terrains (Kusky 1990; Hoffman 1990), or the accretion of a larger juvenile craton (van der Velden and Cook, 2001). Accompanying this debate, are broader issues such as if modern plate tectonic processes even operated in the Archean (cf. de Wit, 1998; Hamilton 1998).

Previous investigations of the tectonic history of the Province, largely focused in the central Slave, have recorded protracted regional shortening accompanied by calc-alkaline plutonism at ca. 2.62 to 2.60 Ga, followed by widespread intrusion of granites between ca. 2.60 and 2.58 Ga, localized uplift, and the culmination of regional high T/low P metamorphism (e.g. Davis and Bleeker, 1999; Kusky, 1993; Thompson, 1989). Results of recent bedrock mapping in the Walmsley Lake area have been integrated with new geothermobarometric and geochronologic data as part of a multidisciplinary geological study in the southeastern Slave Province. This thesis presents a model for the development of two distinct tectonothermal domains in the Walmsley Lake area, formed at different crustal levels in response to a plutono-metamorphic regime similar to that elsewhere in the province. New bedrock mapping, geochronology and thermobarometry data from the southeastern Slave province supports an accretionary tectonothermal model.

The Slave Province is an Archean craton containing a rock record spanning approximately 1.5 billion years of the Earth's Archean history. The distribution of pre 2.85 Ga rocks at surface (Kusky, 1989; Bleeker et al., 1999), and the isotopic signature of Mesoarchean crust at depth (Thorpe, et al., 1992; Davis and Hegner, 1992) indicate basement is restricted to the western and central Slave Province (Figure 1). Supracrustal rocks in the province have been described by numerous workers, most recently Bleeker et al. (1999; and references therein), from whom the following description is largely drawn. Pre 2.85 Ga rocks are overlain by a ca. 2.85 Ga supracrustal succession dominated by quartzite and banded iron formation (the Central Slave Cover Group), which is in turn overlain by parautochthonous, or possibly allochthonous, ca. 2.73-2.70 Ga tholeiitic mafic volcanic rocks, (Kam Group). Tholeiitic basaltic rocks of this age are only known to occur in the western Slave Province. Unconformably overlying the tholeiitic basalts are ca. 2.69 –2.67 Ga calc-alkaline bimodal volcanic rocks (Banting Group) (Isachsen et al., 1991) and a thick package of interbedded greywacke and mudstone (Burwash Formation). The bimodal calc-alkaline volcanic rocks and greywacke - mudstone package occur across the entire Slave Province. Late Archean Timiskaming-type conglomerates (Jackson Lake Formation) unconformably overly this sequence. Their distribution is restricted to isolated, fault-bounded basins of late Archean (ca. 2.6 Ga) age (King and

Helmstaedt, 1997). The Neoarchean geology of the Slave province is represented schematically in Figure 2.

All Archean rocks in the Slave Province were affected by late Archean metamorphism, deformation and plutonism, which occurred grossly synchronously across the entire Slave Province at ca. 2630-2585 Ma (Davis and Bleeker, 1999). Deformation is characterized by multiple phases of folding, and associated penetrative fabrics, followed by late upright open cross folds (e.g. Fyson and Helmsteadt, 1988; Relf, 1992a; Pehrsson and Chacko, 1997). Syn- to post-deformational plutonism in the Slave Province occurred between ca. 2630-2580 Ma, and evolved from early diorite and tonalite through to monzo- to syenogranite (van Breeman et al., 1992; Davis and Bleeker, 1999). In the southern Slave Province ca. 2630-2610 Ma hornblende - biotite tonalite to granodiorite plutons (Defeat Suite) appear to be divided into two age domains with early, ca. 2630 to 2620 plutons in the Yellowknife area, and later ca. 2620 to 2610 Ma plutons to the north (van Breeman et al., 1992; Davis and Bleeker, 1999). No such age variation has been identified in later 2608-2596 Ma "S-type" Prosperous Suite (Henderson, 1985, van Breeman et al., 1992); or Contwoyto Suite (Davis et al., 1994) plutons.

Neoarchean metamorphism in the Slave Province is generally characterized by the andalusite to sillimanite aluminosilicate transition, which classifies it as a low- pressure, Buchan-type metamorphic sequence (Thompson, 1978; Bethune and Carmichael, 1998). At a regional scale, isograds are spatially associated with granitic plutons, indicating a strong genetic link between metamorphism and plutonism. Within this framework, metamorphism in the western Slave Province has been demonstrated to have a complex, multi-staged history (Bethune and Carmichael, 1998). In the Jennejohn Lake area, west of Yellowknife, the cordierite-in "knotted schist" isograd is diachronous, formed by the coalescence of a thermal aureole (Green and Baadsgaard, 1971; Bethune and Carmichael, 1998) associated with the ca. 2620+/-8 Ma Defeat Suite I-type pluton, (Henderson et al., 1987), and the ca. 2596+/-2 Ma Prosperous Suite, S-type, pluton (Davis and Bleeker, 1999).

The areally extensive metagreywacke / mudstone unit is ideal for studying the metamorphic history of the Slave Province in that these lithologies are remarkably homogeneous in composition (Yamashita and Creaser, 1999; Thompson, 1978; Henderson, 1985; Jackson, 1989). The compositional homogeneity of the greywacke / mudstone unit allows direct comparison of mineral assemblages from far removed locations as a function of P-T conditions. Notwithstanding, some variations in metamorphic mineral assemblages are the result of local bulk compositional variations rather than variations in metamorphic conditions (Relf, 1992b; Pattison and Tracy, 1991).

Geology of the Walmsley Lake Area

Rock Types and Ages

Rocks in the Walmsley Lake area comprise late Archean supracrustal rocks intruded by syn-volcanic to post-deformational plutons. Detailed descriptions of supracrustal and plutonic rocks and their field relationships may be found in MacLachlan et al., (2001a; b; 2002); Renaud et al., (2001; 2002); Renaud, (2003); Cairns, (2003); and Cairns et al., (2003) and the map (back pocket).

Metavolcanic rocks are preserved in three separate belts in the study area (Figure 3). The Aylmer Lake volcanic belt, (Renaud et al., 2001; 2002; Renaud, 2003), is exposed south of Aylmer Lake in the northeastern part of the map area. The belt defines a structural dome of submarine to emergent mafic to felsic calc-alkaline volcanic rocks cored by younger plutonic rocks. About 20 kilometres west-southwest of the Aylmer Lake belt, a unit of layered mafic rocks is preserved within a two-mica granite pluton. Although exposure in this area is very poor, geophysical data (Armstrong and Kenny 2001) suggest the unit has significant strike continuity. The unit has been designated the Taylor Lake volcanic belt (Cairns et al., 2003). In the southern part of the study area, the Cook Lake volcanic belt is preserved as a series of arcuate belts of upper amphibolite-facies mafic to felsic volcanic rocks within a composite granodioritic to tonalitic pluton (MacLachlan et al., 2002). Overlying the volcanic rocks in the northern part of the map area is an extensive unit of interbedded greywacke / mudstone. In the south, these rocks comprise partially-melted paragneisses.

Plutonic rocks in the Walmsley Lake area (Figure 3) comprise early syn-tectonic biotite-hornblende tonalite to granodiorite, late- to post-tectonic biotite-muscovite ± apatite ± garnet monzogranite, and post-tectonic biotite monzogranite and K-feldspar megacrystic monzogranite.

The early plutons are compositionally and texturally similar to I-type, Defeat suite (Henderson et al., 1987) and Concession suite (Davis et al., 1994) plutons in the Yellowknife and Contwoyto Lake areas, respectively. These plutons are typically composed of numerous compositionally and texturally variable sills that parallel regional foliation.

Two-mica granitoids in the Walmsley lake area (Figure 3) are compositionally and texturally similar to peraluminous, S-type, plutons elsewhere in the Slave Province, e.g. Prosperous suite, (Henderson, 1985), Contwoyto suite, (Davis et al., 1994).

The most abundant granitoids in the Walmsley Lake area comprise a suite of late, non-foliated, metaluminous to weakly peraluminous, equigranular to K-feldspar-megacrystic granites to granodiorites. These plutons share textural and compositional similarities with the Morose suite (Davidson, 1972; Henderson, 1985) in the Yellowknife area, and the Yamba suite in the Contwoyto Lake area (Davis et al., 1994).

Structural Elements

Structural elements in the study area are described in detail by MacLachlan et al., (2001a, 2002) and Cairns (2003). Key features and timing relationships are summarized below.

D_1 Structural Elements

F_1 folds have been recognized in biotite-zone metasedimentary rocks in the northwestern part of the Walmsley Lake map area, and north of the Aylmer Lake volcanic belt (Figure 3) (MacLachlan et al., 2001a). In the low-grade greywacke / mudstones, F1 folds are isoclinal and distinguished by reversals in younging direction, where both limbs are overprinted by a later (S_2) foliation. North of the Aylmer Lake belt, F_1 chevron folds are refolded by tight F_2 folds, to produce a type-II (Ramsey, 1967) interference pattern (Renaud et al., 2002).

Above the cordierite isograd, an S_1 cleavage is locally preserved as straight, or locally crenulated, biotite + quartz inclusion trails internal to cordierite porphyroblasts. The relationship between F_1 and S_1 is unknown; both structural elements are locally preserved, but nowhere observed in the same outcrop.

D_2 Structural Elements

D_2 in the Walmsley Lake area is characterized by a pervasive, steeply dipping north-northeast to north-northwest striking, slatey to schistose cleavage defined by biotite +/- muscovite +/- cordierite (MacLachlan et al., 2001a). This S_2 surface is axial planar to upright isoclinal folds of bedding (F_2). Cordierite, andalusite, and staurolite porphyroblasts have variable relationships to the S_2 cleavage. In F_2 fold noses, porphyroblasts are typically aligned with their long axes parallel to cleavage-bedding intersections and F_2 fold hinges (Renaud et al., 2002; MacLachlan et al., 2001a). Adjacent to massive late-syn to post-tectonic granite plutons and above the sillimanite-in isograd, peak metamorphic porphyroblasts locally overgrow the S_2 fabric.

Granitoids of the early Defeat-like suite commonly define S_2-parallel dykes a few centimetres to several metres wide within metasedimentary rocks. Locally, they cut S_2 at a low angle.

D_3 Structural Elements

Migmatitic metagreywacke / mudstones in the central Walmsley Lake area commonly contain mesoscopic, overturned to recumbent, tight to isoclinal folds of bedding, S_2, and S_2-parallel granitic sheets. These are designated F_3, and locally are associated with a shallowly-dipping S_3 axial planar cleavage. S_2 is rarely preserved as a crenulated cleavage in F_3 hinge zones; more commonly, the predominant fabric in migmatized rocks is an S_2/S_3 transposition cleavage (MacLachlan et al., 2002), defined by aligned micas, sillimanite, and veins of anatectic neosome. On average, F_3 axial traces plunge shallowly north-northwest or south-southeast, and F_3 axial planes dip shallowly west-southwest.

D_4 Structural Elements

D_4 comprises a conjugate set of map-scale open, upright northeast- and northwest-trending cross folds. A weakly-developed, sub-vertical axial planar S_4 cleavage is locally preserved, and is most easily recognized in recumbently folded (F_3) migmatites where the S_2/S_3 composite fabric is at a high angle to the S_4 cleavage (Cairns, 2003). Mesoscopic- and map-scale dome and basin structures related to D_4 folding are common throughout the map area. At higher grades the dome and basin structure is reflected in the geometry of granitic sheets intruding the sillimanite-bearing and migmatized metasedimentary rocks. At lower grades, F_4 folding is distinguished by the geometry of isograds (MacLachlan et al., 2001a; 2002; Cairns et al., 2003). Despite the noticeable effects of these structures on the regional map pattern, the gentle folding superposed on an already polydeformed terrane precludes constraining the axial traces of F_4 folds in anything but a schematic sense. Late, open, upright cross-folds are reported from many places in the Slave Province, e.g. Contwoyto Lake (Relf, 1992b), Keskarrah Bay, (Jackson, 1989), Indin Lake (Pehrsson and

Chacko 1997), the Nardin Core Complex (Stubley et al., 1995) and the Snare River area (Fyson and Jackson 2003).

Tectonothermal Domains in the Walmsley Lake area

The Walmsley Lake area may be grouped into upper and lower tectonothermal domains based primarily on structural style and metamorphic grade, and to a lesser extent, on lithologic association. The upper domain corresponds to upper crustal levels (5-12 km), and the lower domain to mid-crustal levels (12-20 km).

Upper tectonothermal domain

Rocks of the upper tectonothermal domain are restricted to the northern third of the Walmsley Lake area (Figure 3). The domain is dominated by metasedimentary rocks ranging from sub-biotite to sillimanite grade, and is cut by late-syn to post-tectonic, Prosperous-like, granodiorite to syenogranite plutons. The domain preserves two generations of steeply dipping, upright isoclinal folds and associated fabrics (F_1/S_1 and F_2/S_2). The metamorphic history of the upper tectonothermal domain is diachronous, reflecting the superposition of contact metamorphic haloes upon a regional metamorphic gradient (described in more detail below).

Lower tectonothermal domain

Rocks of the lower tectonothermal domain are located in the central and southern parts of the study area, and comprise uppermost sillimanite zone to extensively melted metasedimentary rocks, and abundant granitoids. Sub-horizontal D_3 fabrics and folds are the predominant structural elements in this domain. At this mid-crustal level, the proportion of plutonic to supracrustal rocks is significantly higher than in the upper tectonothermal domain. Intrusive rocks are primarily Defeat-like tonalites to monzogranite and Morose-like plutons.

Boundary between the upper and lower tectonothermal domains

The boundary between the upper and lower tectonothermal domains is difficult to define throughout most of the study area, as it appears to correspond to a transposition of lower grade, steep D_1/D_2 fabrics by shallow D_3 fabrics at high metamorphic grade (~ melt-in) and as such is transitional in nature. Nevertheless, it is fairly well constrained in two places in the study area. On the west side of Back Lake, sillimanite-bearing metasedimentary rocks contain vertical fabrics, and upright isoclinal folds (Figure 3), typical of the upper tectonothermal domain. In contrast, along the east side of the lake, migmatitic layering dips shallowly, plutonic contacts are sub-horizontal, and recumbent F_3 folds are preserved, characteristic of the lower tectonothermal domain. The transitional domain boundary is constrained to within a kilometre, beneath Back Lake. Fabrics and metamorphic grade within the Aylmer Lake volcanic belt and overlying metasedimentary rocks are characteristic of the upper tectonothermal domain. However, mineral assemblages record a late thermal overprint that can be attributed to M3 (see below), suggesting the lower domain immediately underlies this area. A ca. 100 metre thick, sheared amphibolite occurs at the stratigraphic base of the belt (Renaud, 2003); perhaps this high strain zone separates the upper and lower domains in this area.

U-Pb Geochronology

A number of rocks from across the map area were sampled for TIMS and SHRIMP U-Pb geochronology, to help constrain the timing of deposition, plutonism, and metamorphism in the two tectonothermal domains. Geochronologic data are presented below.

Analytical Techniques

Heavy mineral concentrates were prepared by standard techniques, including crushing, grinding, Wilfley™ table, and heavy liquids. The concentrates were sorted by magnetic susceptibility using a Frantz™ isodynamic separator. Fractions were air abraded following the technique of Krogh (1982). The analytical methods for thermal ionization mass spectrometry (TIMS) analysis of zircon and monazite at the Geological Survey of Canada are summarized by Parrish et al., (1987), and for titanite by Davis et al., (1997). Analytical errors are determined based on the error propagation methods of Roddick (1987), or external error determined by reproducibility of standard zircon solution, whichever is greater. A modified York (1969) regression method was used to calculate discordia upper and lower intercept ages. Detailed descriptions for individual fractions are included in Table 1.

The sensitive high-resolution ion microprobe (SHRIMP) analytical technique for zircon U-Th-Pb age determinations is outlined in detail by Stern (1997) and Stern and Amelin (2003). Zircons were mounted in an epoxy grain mount along with the GSC laboratory zircon reference standard (BR266). The mount was then polished to reveal the grain centers. Analyses were carried out using a primary oxygen ion beam current of 4.2 nA and a sputtering diameter ranging from 10-20 microns. Uncertainty in the normalization of U/Pb ratios to the standard was 1.2 %.

Results of Geochronology

Age of Aylmer Lake and Cook Lake Volcanic Belts

Samples from two of the principal volcanic belts in the area have been dated: 1) a quartz-phyric massive to faintly banded rhyolite crystal tuff (DRA00-K6461) from the "Upper Diverse Volcaniclastic series" (Renaud et al., 2001) of the Aylmer Lake volcanic belt; and 2) an intermediate garnet-hornblende-magnetite-bearing metavolcanic (DRA01-K08) from the Cook Lake volcanic belt.

DRA00-K6461 (Z6538, Felsic crystal tuff, Aylmer Lake volcanic belt): Zircons recovered from the tuff are dominated by clear, colourless prisms. Analyses of six multigrain fractions are concordant to slightly discordant (Table 1, Figure 4a). A linear regression through all six fractions gives an upper intercept of 2676 +7/-3 Ma (L1, Table 2, MSWD 1.83), which is interpreted as the crystallization age of this rock. Two multigrain fractions of pale brown to colourless, unabraded titanite fragments are concordant and slightly discordant, with ^{207}Pb/^{206}Pb ages of 2588 +/-5 Ma and 2575 Ma, respectively. The 2588 Ma age of the concordant titanite fraction is interpreted as the time of metamorphic growth and/or recrystallization of titanite.

DRA01-K08 (Z7251, Intermediate metavolcanic, Cook Lake volcanic belt): This sample yielded few zircons of generally poor quality. Analyses were carried out with the SHRIMP ion probe. Zircons consist of oscillatory-zoned prisms typical of igneous grains. Eleven analyses of eleven individual crystals (Table 3, Figure 4b) yielded a weighted mean ^{207}Pb/^{206}Pb age of 2673 +/-8 Ma MSWD 0.79, interpreted as the crystallization age of this sample, with one analyses rejected as a statistically younger outlier.

The two ages of volcanic rocks from the two belts are within error of each other and similar in age to well documented calc-alkaline volcanic sequences throughout the Slave province.

D_2/M_2 in the Upper Tectonothermal Domain

The timing of D_2/M_2 has been bracketed by dating intrusive phases that post-date and pre-date the development of the D_2 fabric. A maximum age is estimated from the Margaret Lake hornblende diorite (DRA00-K4396), an early, sheet-like intrusion, that contains a strong S_2 foliation. A minimum age bracket was determined by dating two massive, elliptical granite plutons that transect, and therefore post-date, S_2 foliation in the northwestern part of the map sheet. The Marlo Lake pluton (DRA00-K2225) is a massive, K-feldspar megacrystic biotite-monzogranite. The Zyena Lake pluton (DRA00-K4395) is a massive, 2-mica monzo- to syenogranite pluton with accessory blue-green apatite east of Zyena Lake. The pluton produced retrograde rims on M_2 cordierite, and retrograde muscovite overgrowing the S_2 fabric. A third granite, Reid Lake pluton (DRA00-K4339) is a massive 2-mica monzogranite with accessory purple garnet. The pluton in part transects S_2 cleavage, however the cleavage appears to deflect S_2 parallel to its margins in some regions. Field relationships indicate the Reid Lake pluton may be in part syn-D_2, as a weak foliation is locally preserved within the pluton.

DRA00-K4396 (Z6536, Pre-D_2 Margaret Lake hornblende-diorite): Analyses of five multigrain fractions of clear brown, prismatic zircons yield slightly discordant (Z1-Z3) to discordant data (Z4-Z5). The three most concordant results have identical $^{207}Pb/^{206}Pb$ ages (Table 1, Figure 5a). A linear regression through the three fractions, pinned at the origin, yields an upper intercept of 2614 +/-2 Ma (L5, Table 2, MSWD 0.73), which is interpreted as the crystallization age of this sample. Two other fractions (Z4,Z5) are more discordant and do not define a statistically meaningful regression (MSWD =8.73), indicating a more complex Pb-loss history for these fractions. Development of the D_2 fabric preserved within the pluton must have developed at, or after 2614 +/-2 Ma.

DRA00-K2225 (Z6476, Marlo Lake K-feldspar megacrystic granite): Five single grain fractions of euhedral, pale yellow monazite are near concordant (Table 1, Figure 5b) and have a weighted mean $^{207}Pb/^{206}Pb$ age of 2588 +/- 1.6 Ma (MSWD 3.4), which is interpreted as the best estimate for the crystallization age of this pluton.

DRA00-K4395 (Z6527, Post- D_2 Zyena Lake 2-mica granite): A sample of the Zyena pluton yielded zircon and monazite. Analyses of three multigrain fractions of pale brown, prismatic zircon are strongly discordant (Table 1, Figure 5), and do not regress. The 'best-fit' line through the zircon fractions intersects the concordia at 2606 ± 27/-19 Ma with a lower intercept of 1.0 Ga (MSWD = 67).

The significant scatter about this line indicates complex Pb-loss, or other factors disturbing the U-Pb system in zircon. One multigrain fraction of abraded euhedral, pale yellow monazite, and three single grain fractions of unabraded euhedral, pale yellow monazite yield more concordant results (Table 1, Figure 5c). Regression of three of the four monazite analyses yields an upper intercept age of 2605 +2.9/-2.2 Ma. The fourth monazite plots to the left of this line indicating a younger disturbance to the monazite. A discordia line through fractions Z24 and the two most concordant monazite fractions has an upper intercept of 2603 +/-2 Ma (L3, Table 2, MSWD 2.43), which is interpreted as the crystallization age of this sample.

DRA00-K4339 (Z6652, Syn-D_2 Reid Lake 2-mica granite): Zircon and monazite were analysed from this pluton. Five single grain fractions of pale yellow, subhedral monazite fragments yield variably discordant dates (Table 1, Figure 5d), with four of the five analyses defining a discordia line with an upper intercept of 2615 +3.5 /-2.2 Ma (L4, Table 2, MSWD 0.97). The fifth fraction has an older ^{207}Pb/^{206}Pb age (>2620 Ma), and is interpreted to include an inherited component. Zircon consists of prismatic grains with broadly zoned cores and higher uranium, oscillatory-zoned rims. SHRIMP analyses of both cores and rims indicate that, with one exception, there is no significant difference in age between rims and cores (Figure 5e, Table 3). A weighted mean age of 2621± 7.4 Ma (MSWD = 1.9, n= 11) is calculated excluding two high U altered rims (reverse discordance), an inherited core with an age of ~ 2.71 Ga, and one young analyses. The latter was rejected as a statistical outlier (Ludwig, 2001). This age is older but within error of the monazite age. The Tukey's biweight age of 2615 ± 8 Ma is identical to the monazite age determined by ID-TIMS. The monazite age of 2615 +3.5/-2.2 Ma is interpreted as the best age estimate for crystallization of this granite.

D_3/M_3 Transition Zone and Lower Tectonothermal Domain

Three samples of metasedimentary rocks and two samples of granitoid rocks were collected from the lower tectonothermal domain to assess the timing of plutonism and M_3/D_3. The metasedimentary samples include: 1) a garnet-biotite psammite (DRA00-K4394), and 2) a migmatized pelite (DRA00-K4276) from the east side of Back Lake. In this area, the main fabric is S_2, however localized recumbent F_3 folds of S_2, indicate that this area has been affected by D_3; 3) a sample of migmatized metapelite (DRA01-K2059) from south of Walmsley Lake within a refolded recumbent F_3 fold that outlines an F_4 structural basin. The migmatite contains an F_3 crenulation cleavage and was sampled to determine the timing of partial melting and D_3 deformation.

The granitoid samples comprise: 1) a two-mica granodiorite with accessory blue-green apatite from the Cook Lake volcanic belt area (DRA01-K14). Petrographically this sample resembles the Zyena pluton from the upper domain. The unit cuts bedding and S_2 in sillimanite-grade metagreywackes, but contains an S_3 foliation. It was sampled to provide a maximum age for S_3; 2) sample 5105, from a large body of massive, biotite monzogranite that contains septa of supracrustal rocks and dominates the southwestern part of the map sheet. Sample 5105 is representative of an abundant biotite monzogranite the unit was sampled to provide the age of peak plutonism in the lower tectonothermal domain.

DRA00-K4394 (Z6528 Garnet-bearing psammite, Back Lake): Three multigrain fractions of pale yellow, subhedral to euhedral monazite are slightly discordant and give a weighted average $^{207}Pb/^{206}Pb$ age of 2585 +/- 3.5 Ma (MSWD 3.4, Table 1, Figure 6a), interpreted as the time of metamorphic monazite growth.

DRA00-K4267 (Z6702 Migmatized pelite, Back Lake): Three single grain monazite analyses from a sample of partially melted pelite yielded discordant analyses with a spread in $^{207}Pb/^{206}Pb$ age from 2590 to 2585(Figure 6b, Table 1). The range of $^{207}Pb/^{206}Pb$ dates indicate the monazites are likely to preserve a complex history, but support a significant post-2590 Ma recrystallization or growth event, possibly associated with the partial melting event. In conjunction with the monazite results from the previous sample a ca. 2585 Ma metamorphism is indicated.

DRA01-K2059 (Z7076, Walmsley Lake migmatite): Three single grain fractions of pale yellow, euhedral monazite have a weighted average $^{207}Pb/^{206}Pb$ age of 2582 +/-1 Ma (MSWD 0.17, Table 1, Figure 6c), interpreted as the time of monazite growth during partial melting and D_3 deformation. A fourth single grain fraction of pale yellow euhedral monazite has an older $^{207}Pb/^{206}Pb$ age of 2586 Ma and is interpreted to have an inherited component, likely from an earlier metamorphism or possibly a detrital component.

DRA01-K14 (Z7250, Two-mica granodiorite, Cook Lake volcanic belt): Three single grain fractions of pale yellow, subhedral to euhedral monazite are slightly discordant and have a weighted average $^{207}Pb/^{206}Pb$ age of 2602 +/- 2.5 Ma (MSWD 2.1, Table 1, Figure 6d), which is interpreted as the crystallization age of this rock. This provides a minimum age for S_2 in the lower domain similar to that provided by the Zyena pluton in the upper domain, and a maximum age for development of the S_3 cleavage.

*5105 (Z7648, Monzogranite, Goodspeed Lake area):*Monazite and zircon were analysed from this monzogranite. Zircons are dominated by euhedral prismatic grains. Four analyses yield highly discordant ages that do not define a simple discordia (Figure 6e). Three monazite analyses yield concordant ages with $^{207}Pb/^{206}Pb$ dates between 2579 and 2582 Ma. The weighted mean of the monazites dates gives an age of 2581 ± 4 Ma (MSWD = 4.9). This is interpreted as the best estimate of the crystallization age of the pluton. Although discordant, two of the zircon fractions have older $^{207}Pb/^{206}Pb$ dates (2588, 2603 Ma), possibly indicating inheritance.

Petrogenetic constraints on P-T conditions

Isograds in the greywacke / mudstone sequence are defined based on the appearance of a particular phase in beds of the most pelitic bulk composition. As true pelitic compositions are rare, the isograds do not necessarily correspond to reactions shown on petrogenetic grids developed for pelites. In fact, a given isograd on the map may reflect the first appearance of a phase as the end product of different metamorphic reactions, occurring at different times, at different P-T conditions, in rocks of different bulk compositions, and in response to various geological events. In the following sections the metamorphic reactions attributed to the mineral associations observed in the area are presented.

Greenschist-facies assemblages

The lowest grade metasedimentary rocks contain the assemblage chlorite + muscovite + quartz + plagioclase +/- K-feldspar. Pelitic compositions contain a slaty cleavage with dull cleavage faces. A small inlier with this assemblage was mapped west of Marlo Lake, in the northwestern part of the study area (MacLachlan et al., 2001a) (Figure 3). P-T conditions for this assemblage are constrained to below the biotite-producing reaction:

chlorite + K-feldspar ↔ biotite + muscovite + quartz + H_2O (1)

(Spear and Cheney, 1989).

Pelitic rocks above the biotite-in isograd (Figure 3) contain the assemblage biotite + muscovite + quartz + plagioclase +/- chlorite. The grain size of biotite and muscovite crystals increases up-grade from the biotite-in isograd, from slaty near the isograd, to phyllitic farther upgrade, to schistose near the cordierite-in isograd.

Amphibolite-facies assemblages

The cordierite-in isograd is related to the continuous KFMASH reaction:

chlorite + muscovite + quartz ↔ cordierite + biotite + H_2O (2)

corresponding to P-T conditions of 550-600°C at 2-3 Kbar (Pattison, 2001) (Figure 7). At slightly higher temperatures, cordierite and andalusite locally co-exist, likely produced by the discontinuous reaction:

chlorite + muscovite + quartz ↔ cordierite + andalusite + biotite + H_2O (3)

(Pattison, 2001) (Figure 7).

Immediately upgrade of the sillimanite-in isograd, andalusite and sillimanite co-exist as isolated phases within the rock. A few kilometres upgrade (map view), sillimanite occurs as thin fibrolite mantles overgrowing andalusite. The latter texture argues for the polymorphic transition reaction:

andalusite ↔ sillimanite (4)

The isolated sillimanite grains found near the sillimanite-in isograd may have formed by a different reaction such as:

cordierite + muscovite + quartz ↔ biotite + sillimanite +H_2O (5)

(Harte and Hudson, 1979).

Upper Amphibolite Assemblages

Migmatites with very low percentages of *in situ* melt have monzogranitic neosome compositions. These migmatites may have formed due to vapour-absent melting from muscovite decomposition, or melt generated from the presence of small amounts of metamorphic pore fluids. Subanatectic metasedimentary rocks at sillimanite grade rarely contain muscovite; therefore vapour-absent melting due to muscovite breakdown cannot be invoked for significant degrees of melt generation. Migmatites with a larger degree of melting, and evidence of melt migration and escape, commonly have tonalitic to trondhjemitic neosomes. The vapor source for larger degrees of partial melting likely involves biotite decomposition, e.g.:

biotite + sillimanite + quartz ↔ cordierite + K-feldspar + melt (7)

(Clemens and Vielzeuf, 1987; Pattison and Tracy 1991), (Figure 7).

Evidence for the reaction above includes the common presence of blue cordierite (*var.*iolite) in neosome in migmatites with high melt proportions. This reaction occurs at temperatures above 700°C.

Collectively, the mineral assemblages define a low pressure, high temperature facies series, typical of Slave Province metamorphism.

Constraints on pressure-temperature-time paths

Segments of qualitative pressure-temperature-time (P-T-t) paths can be inferred for the Walmsley Lake area, based on porphyroblast-fabric relationships observed in outcrop and thin section, and P-T constraints using published petrogenetic grids.

The upper tectonothermal domain preserves evidence for two tectonothermal events (D_1/M_1, and D_2/M_2; see above). Specific porphyroblast-fabric relationships are described below.

Cordierite porphyroblast-fabric relationships

Cordierite is the most widespread porphyroblast in the upper tectonothermal domain and textural evidence suggests most cordierite was formed during the D_2/M_2 event. Cordierite porphyroblasts typically both overgrow, and are wrapped by the S_2 fabric. Locally, an S_1 fabric, defined by aligned biotite and quartz inclusions, is preserved within cordierite porphyroblasts, oblique to the external fabric (MacLachlan et al., 2001a). Rarely an S_2 crenulation cleavage is preserved in the outer portion of individual porphyroblasts. S_1 cleavage is locally observed within the matrix of these rocks in microlithons between S_2, although more commonly it is transposed into S_2. Collectively these relationships suggest protracted growth of cordierite occurring during early, middle, and late to post D_2 (Zwart, 1962).

Several texturally distinct cordierite porphyroblast-fabric relationships co-exist in the Reid Lake / Zyena Lake area (Figure 3). One generation of cordierite is stretched ca. 10:1 along S_2 foliation, and does not preserve an internal S_1 cleavage. This early generation co-exists with cordierite porphyroblasts with the more typical porphyroblast-fabric relationships outlined above. The early, ribboned cordierites are interpreted to be M_1 porphyroblasts, indicating amphibolite facies conditions existed prior to D_2 deformation. Along the western shore of Zyena Lake both of these generations of cordierite are rimmed with fine-grained retrograde muscovite and chlorite after cordierite (Figure 8a). The "rimmed cordierite" isograd, in map view, parallels the contact of the ca. 2603 Ma Zyena Lake pluton (Figure 3) at a distance of approximately 2 kilometres. These relationships indicate two discreet stages of amphibolite-facies metamorphism with conditions suitable for cordierite growth occurring prior to ca. 2603 Ma. They further suggest that temperatures did not exceed cordierite-forming conditions after ca. 2603 Ma, and likely were below these conditions prior to this time.

Staurolite + cordierite + aluminosilicate porphyroblast-fabric relationships

Metasedimentary rocks overlying the Aylmer Lake volcanic belt have an assemblage quartz + plagioclase + biotite + staurolite + cordierite +/- andalusite +/- sillimanite +/- garnet +/- muscovite. Porphyroblast-fabric relationships in staurolite-bearing metasedimentary rocks suggest a complex paragenesis.

Most staurolite porphyroblasts have inclusion-rich cores, overgrown by inclusion-poor rims. Quartz and opaque inclusions in staurolite porphyroblasts preserve an internal fabric oblique to the external (S_2) fabric and must therefore have grown before D_2 to preserve the S_1 fabric (Figure 8b) (Zwart, 1962). These staurolite porphyroblasts are variably resorbed, and commonly rimmed by fine-grained quartz. Early andalusite porphyroblasts are subhedral to anhedral, preserve an internal S_1 fabric, and typically are rimmed by cordierite. Both andalusite, and the generation of staurolite described above are interpreted to pre-date D_2 and are attributed to M_1 metamorphism. Cordierite porphyroblasts contain an S_2 fabric with the external S_2 fabric gently wrapping the porphyroblast, implying late D_2 growth. Above the sillimanite isograd, sillimanite occurs as very fine-grained fibrolite needles overgrowing, and therefore postdating, S_2.

Although muscovite, cordierite, staurolite and biotite coexist in some of the staurolite-bearing rocks, Pattison et al., (1999) argued that this does not represent an equilibrium assemblage, but is the product of multiple generations of metamorphism. The paragenesis of the staurolite-bearing metasedimentary rocks provides significant information on the P-T path of these rocks. Following the reasoning of Pattison et al., (1999), early (i.e. peak M_1, syn- to late-D_1) staurolite and andalusite were derived at intermediate pressures by reactions (Figure 9):

muscovite + chlorite + quartz ↔ staurolite + biotite + water,

and

muscovite + staurolite + chlorite + quartz ↔ andalusite + biotite + water respectively.

Decompression of these rocks results in reactions:

staurolite + muscovite + quartz ↔ andalusite + biotite + water,

and

andalusite + biotite + quartz + water ↔ muscovite + cordierite

The latter reaction resulted in growth of late to post D_2, post-peak M_2 cordierite porphyroblasts. The presence of randomly-oriented sillimanite overgrowing all fabrics suggests post-D_2 ~isobaric heating to temperatures within the sillimanite stability field (Figure 9). The presence of ca. 2588 Ma titanite in the underlying volcanic belt provides evidence for the timing of this late metamorphic event. This age overlaps, within error, with the timing of melt generation and D_3 in the lower tectonothermal domain (ca. 2586 Ma).

Sillimanite porphyroblast-fabric relationships

Within the upper tectonothermal domain, sillimanite occurs in three distinct morphologies: 1) compact fibrolite knots; 2) as fibrolite rims on late syn, and post-

D_2 cordierite and andalusite porphyroblasts; and 3) as individual or mats of needles in association with biotite. Fibrolite knots are light cream coloured, 1 to 4 millimetre dense bundles of randomly or weakly oriented fibrolite needles (Figure 8c). The "fibrolite-knot" morphology of sillimanite is found in a zone rimming a small pluton between Margaret and Munn Lakes, and along the western shore of Back Lake in a zone paralleling the contact of an intrusive migmatite (Figure 3). Sillimanite mantling andalusite and cordierite porphyroblasts occurs as randomly-oriented fibrolite. This morphology is observed in the central Reid Lake area, and on the eastern shore of Box Lake (Figure 3). The remainder of sillimanite in the upper tectonothermal domain occurs as dispersed fibrolite crystals, or tiny mats, growing in random orientations, typically nucleating on the {001} surface of biotite crystals.

All three modes of sillimanite in the upper tectonothermal domain typically overgrow S_2, and thus are post D_2. Given its spatial association with post-D2 plutons and with rocks of the lower tectonothermal domain, sillimanite is interpreted to have formed in response to heat advected from late granitoids and from mid-crustal levels.

Within the lower tectonothermal domain, sillimanite occurs as millimetre to several centimeter long mats of fibrolite needles, and as elongate masses of prismatic sillimanite aligned within the main (S_3) foliation or locally parallel to F_3 fold axes. Migrating granitic dykes of locally-derived anatectic melt cross-cut, but are strongly flattened into the main foliation (Cairns, 2003). Both observations indicate deformation was coincident with peak M_3 conditions in the lower tectonothermal domain. Isotopic (this study) and chemical (Schultz, 2002) monazite ages from anatectic melt pods and restitic metasedimentary rocks, have yielded ages of ca. 2582-2589 Ma; this is interpreted as the age of metamorphic monazite growth in the lower tectonothermal domain.

Quantitative Thermobarometry

Mineral assemblages in the metagreywacke / mudstone package in the study area are suitable for quantitative thermobarometric study. Detailed petrography was performed on approximately 150 thin sections, and samples for thermobarometry were selected based on:

1) the presence of a mineral assemblage suitable for quantitative P-T determination (garnet + plagioclase + biotite + aluminosilicate + quartz +/- muscovite +/- staurolite +/- cordierite) (Table 4);

2) evidence of equilibrium textures (e.g. lack of embayments);

3) a lack (or paucity) of retrograde and/or alteration textures and phases; and

4) distribution across the Walmsley Lake area, both geographically and with respect to metamorphic grade.

Microbeam analysis of minerals from selected samples was carried out at the University of Alberta using a JEOL 8900 electron microprobe. Analyses of garnet and plagioclase used an accelerating voltage of 15 kV, a beam current of 15 nA, and a 1 μm beam diameter. Biotite, muscovite and cordierite analyses were carried out using similar beam conditions but a beam diameter of 5 μm to prevent sample degradation during analysis. Analytical precision is on the order of 1-2% relative for major oxides, and 10-20% relative for low concentration (<1%) oxides. Microprobe data were reduced using ZAF reduction procedures. Representative garnet, plagioclase and biotite analyses are given in Table 5, representative cordierite and staurolite analyses are given in Table 6.

Quantitative mineral analyses were carried out on garnet-bearing samples from the cordierite to migmatite zone. Mineral assemblages are presented in Table 4. For each sample at least one garnet porphyroblast was analyzed along a rim to core transect, with analyses every 5 μm for the first 50 μm, followed by analyses every 10 μm for the next 100 μm, then every 50 μm for the next 500 μm. For garnet porphyroblasts larger than 1300 μm, subsequent analyses were taken every 100 μm to the centre of the garnet. At least three spot analyses per crystal were performed on biotite and plagioclase grains: in contact with; within 1 millimetre of; and >1millimetre from the analyzed garnet porphyroblast.

Zoning profiles for Fe, Mg, Ca and Mn show systematic variations in garnet composition from core to rim. Within the upper tectonothermal domain, garnets from cordierite-grade rocks display two styles of zoning. (Figure 10a,b). Lower-grade garnets from the cordierite zone are characterized by core to rim decreases in spessartine and flat Fe/Fe+Mg ratio (Figure 10a). Garnets from well above the cordierite-in isograd show increases in Fe/Fe+Mg ratio and spessartine content within 50 to 100μm of the rim (Figure 10b). We interpret this to be the result of retrograde Fe-Mg exchange between the garnet rim and other ferromagnesian phases. Analytical points used for thermobarometric calculations were taken internal to this zone to minimize these retrograde effects.

Garnets from migmatitic rocks of the lower tectonothermal domain have variable compositional profiles, and complex zoning. Sample 2133 is an atypically large, subhedral garnet characterized by a spessartine-rich, grossular-, pyrope-, almandine-poor core, corresponding to an internal zone with abundant inclusions arranged in a crude, slightly curved, fabric. Elemental profiles within the area with slightly helicoid inclusion trails are similar to those found in sillimanite- and upper cordierite-zone garnets of the upper tectonothermal domain, though the overall abundance of Mn, and to a lesser extent Mg are lower. At the edge of the inclusion-rich core, elemental abundances are quite erratic, possibly reflecting complications associated with prograde garnet growth during M_3 superposed on post-M_2 retrograde effects. Within the inclusion-poor outer zone, almandine, spessartine and grossular content decrease toward the rim of the garnet, accompanied by an increase in pyrope (Figure 10c). The rim of this garnet records significantly different P-T conditions than those recorded in the core of the garnet, and in lower-grade garnets from other samples. Higher-grade samples show significant spessartine enrichment within 20μm of the rim, suggestive of garnet resorbtion.

At all metamorphic grades, biotite shows little within-sample compositional variation, and no systematic compositional variation with respect to distance from garnet porphyroblasts. Plagioclase similarly shows little intra-sample variation, and only two samples show compositional variation with respect to distance from garnet porphyroblasts. Due to the small number of analyzed points per plagioclase crystal, no information exists on internal zoning within individual plagioclase crystals. Cordierite and muscovite show little within-sample compositional variation.

Thermobarometric Methods

Thermobarometry was carried out on selected samples. The garnet-biotite, Fe-Mg exchange (GARB) equilibrium:

$Fe_3Al_2Si_3O_{12} + KMg_3AlSi_3O_{10}(OH)_2 \leftrightarrow Mg_3Al_2Si_3O_{12} + KFe_3AlSi_3O_{10}(OH)_2$
almandine + phlogopite ↔ pyrope + annite

was used to obtain a temperature estimate on all samples. The garnet-plagioclase-aluminosilicate-quartz (GASP) net transfer equilibrium:

$Ca_3Al_2Si_3O_{12} + 2Al_2SiO_5 + SiO_2 \leftrightarrow 3CaAl_2Si_2O_8$
grossular + aluminosilicate + quartz ↔ anorthite

was used for pressure estimates. Quartz and aluminosilicate involved in this reaction were considered pure phases. Cordierite compositional data from samples 287 and 2133 were used to carry out cordierite equilibria thermobarometry using:

$2\ Fe_3Al_2Si_3O_{12} + 4\ Al_2SiO_5 + 5\ SiO_2 \leftrightarrow 3\ Al_3Fe_2Si_5(AlO)_{18}$
2 Almandine + 4 Andalusite + 5 Quartz = 3 Fe-Cordierite

as a pressure estimate, and

$2\ Fe_3Al_2Si_3O_{12} + 3\ Al_3Mg_2Si_5(AlO)_{18} \leftrightarrow 2\ Mg_3Al_2Si_3O_{12} + 3\ Al_3Fe_2Si_5(AlO)_{18}$
2 Almandine + 3 Mg-Cordierite = 2 Pyrope + 3 Fe-Cordierite

for temperature.

Pressure and temperature determinations were calculated using TWQ ver. 2.02b (Berman, 1997). Activity-composition models used for TWQ calculations were those of Berman and Aranovich (1996a; 1996b) for garnet, biotite, and cordierite, and Fuhrman and Lindsley, (1988) for plagioclase. To avoid the effects of re-equilibration during cooling, near-rim garnet compositions with the lowest Fe/(Fe+Mg) were selected for thermobarometric analysis (Figure 10). Biotite and plagioclase compositions were numerically averaged for thermobarometric calculations unless a systematic compositional variation was noted. In cases where such a variation was observed, the composition of the plagioclase grain closest to the garnet porphyroblast was used for thermobarometric calculations.

Quantitative thermobarometry on these samples is hampered by mineral composition. The grossular content of garnet is lower than recommended for reliable use of the Garnet – Aluminosilicate – Plagioclase geobarometer (Essene, 1989). The product of (X_{grs})(X_{an}) is invariably <0.05, and thus less precise for use in GASP geobarometeric calculations (Todd, 1998). Lower-grade samples are at upper greenschist to lower amphibolite grade, and thus below the range of experimental calibrations for most activity models (e.g. Essene, 1989). Numerous samples were taken from the upper cordierite lower sillimanite zones. Temperatures of these samples all fall well within the sillimanite stability field. Mn enrichment found on the rims of higher-grade samples in the Walmsley Lake area may be indicative of retrograde net transfer reactions (garnet dissolution). Kohn and Spear (2000) warn garnets displaying these features may yield anomalously high temperatures. Despite these limitations, P-T estimates from the dataset appear to provide systematic results, consistent with field observations. Thermobarometric results for samples are summarized in (Table 7) and (Figure 11).

Thermobarometric Results

Upper Tectonothermal Domain

Two samples from the upper tectonothermal domain were selected to constrain the pressure-temperature conditions of the cordierite-in isograd. Sample 0287, from an atypically aluminous bed in semipelitic metasedimentary rocks with the assemblage quartz – biotite – muscovite – plagioclase – andalusite – garnet - cordierite was collected west of Zyena Lake. Geothermobarometric analysis of sample 0287 yielded a GARB / GASP estimate of 510°C at 2.1 kbar, within error of the result 590°C at 3.3 kbar obtained from cordierite equilibria (Figure 12). Sample 0293 was collected from semipelitic metasedimentary rocks proximal to the cordierite-in isograd. Thermobarometry on this sample yielded 560°C and 3.4kbar, in good accord with petrogenetic grid constraints for the cordierite-in reaction (Pattison 2001) (Figure 7).

Several samples from just below the sillimanite-in isograd were analyzed. Samples 0174, 0383, 0396 and 0613 all plot in the temperature range ca. 610 to 620°C; pressures are more variable ranging from ca. 4.5 to 6.3kbar (Figure 11, Table 7). The range in pressures may reflect the universally low grossular content of these garnets, and the resultant uncertainty in activity models for grossular in almandine at low concentrations (Essene, 1989; Todd, 1998).

Geothermobarometry on semipelitic rocks with fibrolitic sillimanite overgrowing biotite (Samples 4085, 0032b, 0220, 1026, 1074, and 2326b) gave P-T estimates of ca. 600 to 640°C and ca. 4.2 to 5.1kbar (Figure 11, Table 7). These data overlap with P-T estimates from the upper cordierite zone.

Lower Tectonothermal Domain

Sample 2133 (Figure 9c) contains the equilibrium assemblage garnet + biotite + cordierite + K-feldspar + sillimanite, indicating uppermost amphibolite-, transitional to granulite facies conditions. Thermobarometric analysis of this sample (Figure 11, Table 7) gives 7.0kbar at 710°C using GARB / GASP and 6.0 kbar at 690 °C from cordierite equilibria (Figure12).

Discussion

Metamorphism and deformation in the upper tectonothermal domain occurred in two stages of similar style (Figure 13). The earlier event (D_1/M_1) involved regional folding and fabric development at greenschist- to amphibolite-facies conditions (see above). Its absolute timing is poorly constrained between sediment deposition (ca. 2.66 Ga) and emplacement of the Margaret Lake pluton (2614 +/-2 Ma). The later event (D_2/M_2) is recorded by fabrics formed at mid-greenschist to upper-amphibolite facies conditions. The timing of D_2 is broadly constrained by the 2614 +/-2 Ma Margaret Lake pluton, which contains the D_2 fabric, and the 2603 +/-2 Ma Zyena pluton, whose alteration halo overprints M_2 porphyroblasts (Figure 13).

Locally in the upper tectonothermal domain, evidence exists for late thermal overprinting on peak M_2 assemblages. In some cases, e.g. west of Margaret Lake, late mineral growth is attributed to proximity to Prosperous-like plutons, similar to those documented elsewhere in the Slave Province (e.g. Bethune and Carmichael 1998; Davis and Bleeker, 1999). Elsewhere, e.g. in metasedimentary rocks overlying the Aylmer Lake volcanic belt and along the southeastern shore of Back Lake, the thermal overprint is interpreted to be related to heat advected from the lower tectonothermal domain during M_3 anatexis.

No evidence for D_1/M_1 was observed in the lower tectonothermal domain; however, fabrics associated with D_2/M_2 are locally preserved. Significant reworking during D_3/M_3 overprinted D_2 fabrics under upper amphibolite facies conditions, to an extent that the predominant fabric preserved in the lower domain is associated with D_3. Metamorphic monazites pin D_3/M_3 to ca. 2588 -

2583 Ma (this study; Schultz 2002). This age range overlaps within error to the age of the 2581 +/- 4 Ma Goodspeed Lake granite, and is interpreted to be the age of the muscovite-biotite granite that is widespread throughout the lower tectonothermal domain (above; see Figure 13).

When developing models for the tectonometamorphic evolution of the Walmsley Lake area, the following characteristics must be considered:

1) Early progressive crustal thickening was characterized by the development of upright isoclinal folds, penetrative fabrics and diachronous peak thermal conditions following maximum thickening (M_1/D_1 and M_2/D_2);

2) Tight to isoclinal recumbent folds and associated shallow fabrics are restricted to the lower tectonothermal domain, and were accompanied by extensive anatectic melting of metasedimentary rocks (M_3/D_3);

3) The upper and lower tectonothermal domains were apparently decoupled during D_3.

Textural evidence with respect to porphyroblast timing (Figure 9), and peak thermal conditions following fabric development in the upper tectonothermal domain support the clockwise P-T loops proposed in Figure 11. This model is consistent with the metamorphic style described in the western Slave Province, (Bethune and Carmichael, 1998), and is attributed to moderate crustal thickening, heating, and associated plutonism at upper crustal levels (cf. Spear, 1995). The timing of this thickening is constrained to pre-ca. 2614 Ma (D_1) and between ca. 2614 and 2603 Ma (D_2). These may represent two distinct shortening events, or progressive shortening and crustal thickening over a protracted timeframe. Although less well preserved, textural and geochronologic evidence suggest the lower tectonothermal domain was subjected to the same shortening event(s).

Following crustal thickening, rocks in the lower tectonothermal domain were extensively melted, and at ca 2.58 Ga, intruded by abundant muscovite-biotite monzogranite and K-feldspar megacrystic monzogranite. Granites of this age, although present locally, are much less common in the upper tectonothermal domain. Widespread anatexis and associated melt softening in the lower domain likely resulted in distinctly different rheologies in the upper and mid crust, and may explain the distribution of these rocks between these two crustal levels.

Radiogenic heating combined with conductive heating from trapped granitic melts would have caused significant rheologic softening of the lower tectonothermal domain. We propose that the lower domain vertically collapsed under the weight of the overlying upper domain, and in so doing underwent further decompression melting, and became structurally decoupled from the upper domain. This process is consistent with development of recumbent folds in the lower domain, flattening of originally steep tectonic fabrics, and the superpositon of younger sub-horizontal fabrics. This model is summarized in Figure 14.

The energy required for mid-crustal anatexis may be derived from one or both of two sources: radiogenic heat build-up in over-thickened crust, and/or advection of heat from the mantle due to lithospheric delamination. Either of these models could provide the energy necessary to drive mid-crustal anatexis, rheological softening, and gravity-driven collapse. Derivation of anatectic melt from radiogenic heating is strongly dependant on the radiogenic heat producing element content of the source material. A thickened pile of immature sediments, such as the metasedimentary rocks of the Yellowknife Supergroup, is an ideal, heat-producing element enriched source (Patiño-Douce et al., 1990). The high heat-producing element content of these rocks is corroborated by the analyses of Yamashita and Creaser (1999). Thermal-kinetic modeling indicates that radiogenic heat build up in over thickened crust can produce large volumes of magma at mid and lower crustal levels (Gerdes et al., 2000). Lithospheric delamination has also been invoked as an efficient mechanism of heat transfer to mid-crustal levels (e.g. Nelson, 1992). In this model, some portion of the thickened lithospheric root delaminates and founders in the asthenosphere. Upwelling hot asthenosphere raises the temperature of the lower crust causing melting, and these melts intrude the middle crust, causing melting at mid-crustal levels (Sandiford, 1989; Nelson, 1992). The absence of mafic mantle-derived magmas at mid-crustal levels in the Walmsley Lake area qualitatively argues against a lithospheric delamination hypothesis, as intrusion of mantle-derived material to mid-crustal levels is expected in this model. While neither mechanism can be discounted given current data, we suggest heat build up in an overthickened, radiogenic element-enriched crust as the most likely cause of anatexis and subsequent collapse and decoupling of the lower tectonothermal domain.

Post-thickening anatexis, rheological softening and extensional flow is proposed as a common mechanism for gravitational accommodation in modern areas of over-thickened continental crust, whether in a collisional (e.g. Himalayas; Beaumont et al., 2001; Hodges, 2000), or an accretionary (e.g. Sevier Hinterland of the Cordillera; Patiño-Douce et al., 1990) tectonic setting. Thermomechanical modeling of modern and paleo convergent orogens indicate mid-crustal detachment is the expected response to even moderate degrees of crustal thickening, whether the crustal heat budget is controlled by mantle influence (Sandiford, 1989; Nelson 1992) or internal radiogenic heating (Gerdes et al., 2000). For example, seismic reflection studies in the Himalayas indicate a zone of partially molten middle crust (Hauck et al., 1998, Royden et al., 1997), which is actively deforming and collapsing in response to continued crustal thickening. The metamorphic and structural topology of the lower tectonothermal domain in the Walmsley Lake area is consistent with the topology predicted from thermo-mechanical modeling, and modern observations of gravitational accommodation in overthickened crust.

Recent deep-penetrating reflection seismic experiments across the southwestern Slave province have identified a structure interpreted as a Neoarchean crustal block at depth beneath the western Slave province. It is proposed the crustal block collided with and indented the western Slave province ca. 2.65 – 2.58 Ga (van der Velden and Cook, 2001). While the surface expression of the Neoarchean suture zone is not presently recognized, isotopic proxies for Mesoarchean crust place this boundary ca. 60 kilometres west of the Walmsley Lake area. Within this tectonic framework, the Walmsley Lake area exhibits a crustal architecture analogous to mid-crustal levels imaged in the forelands of modern continent-continent collisional orogens such as the Himalayan Tibetan Plateau. The Walmsley data supports collisional Neoarchean tectonic assembly of the Slave craton, and is consistent with the idea that Archean tectonic processes operated similarly to modern equivalents.

Figure Captions

Figure 1. Map of the Slave Structural Province showing Walmsley Lake map area and the location of areas mentioned in the text. BRL - Brislane Lake, HL - Healey Lake, JL - Jennejohn Lake, AL - Artillery Lake. Modified from (Fyson, 1996). Isotopic boundaries, Pb- filled circles after (Thorpe et al., 1992), Nd - open circles after (Davis and Hengner, 1992; Davis and MacLachlan, in preparation).

Figure 2. Schematic diagram illustrating principal geological events in the Slave Province, after Davis and Bleeker, (1999).

Figure 3. Simplified geological map of the Walmsley Lake area, NTS 75N (after Cairns et al., 2003). Features labeled on map and referred to in text: AL-Aylmer Lake, ArL-Artillery Lake, BL-Back Lake, CL-Cook Lake, FL-Fletcher Lake, KL-Kirk Lake, ML-Margaret Lake, MaL-Marlo Lake, MuL-Munn Lake, RL-Reid Lake, WL-Walmsley Lake, ZL-Zyena Lake, ALVB-Aylmer Lake volcanic belt, CLVB-Cook Lake volcanic belt, TLVB-Taylor Lake volcanic belt. Numbers in squared boxes are thermobarometry sample locations referred to in text. Numbers in circles refer to geochronology sample locations referred to in text. 1) DRA00-K6461, felsic tuff, Aylmer Lake volcanic belt 2) DRA01-K08, intermediate Metavolcanic, Cook Lake volcanic belt 3) DRA00-K4396 Margaret Lake hornblende diorite 4) DRA00-K2225 Marlo Lake K-feldspar megacrystic granite 5) DRA00-4395 2-mica granite, Zyena Lake 6) DRA00-K4339 2-mica granite

Reid Lake 7) DRA00-K4394 Back Lake garnet-bearing psammite 8) DRA01-K2059 Walmsley Lake migmatite 9) DRA01-K5536 Cook Lake 2-mica granodiorite 10) DRA02-5105 Goodspeed Lake biotite monzogranite.

Figure 4. U-Pb concordia plots for volcanic rocks, ellipses reflect 2σ uncertainties. See text for discussion, locations given in figure 2. Z- zircon; M-monazite; T- titanite.

Figure 5. U-Pb concordia plots for upper lithotectonic domain rocks, ellipses reflect 2σ uncertainties. See text for discussion, locations given in figure 2. Z-zircon; M-monazite; T- titanite.

Figure 6. U-Pb concordia plots for lower lithotectonic domain rocks, ellipses reflect 2σ uncertainties. See text for discussion, locations given in figure 2. Z-zircon; M-monazite; T- titanite

Figure 7. Petrogentic grid showing reactions pertinent to Walmsley Lake sediments grid topology after Pattison, (2001). Position of garnet + cordierite equilibria after Spear et al., (1999).

Figure 8. A i) Cordierite porphyroblasts with retrograde very fine-grained chlorite + muscovite rims. Rimmed cordierite porphyroblasts are found within two kilometres in map view of the ca. 2603 Ma Zyena Lake pluton. Metamorphic

regime had cooled to chlorite + muscovite forming conditions by this age. ii) Photomicrograph of cordierite porphyroblast with retrograde chlorite + muscovite rim, crossed polars. Scale bar 5 milimetres length. Cordierite porphyroblasts exhibit a moderately well developed crenulation cleavage developed internal to porphyroblast, an external (S_2) fabric wrapping the porphyroblast, and well-developed quartz pressure shadows. Growth of cordierite porphyroblast occurred early during D_2.

B i) Compact sillimanite knots in pelitic layers of metasedimentary rocks. ii) Photomicrograph of fibrolitic sillimanite knot (Sil), and cordierite porphyroblast (Crd). Sillimanite randomly overgrows the S_2 fabric, indicating growth post D2. Scale bar is ca. 1 millimetre long; the photo is taken in plane polarized light.

C i) Staurolite (St), andalusite (An), and cordierite (Crd) porphyroblasts in semipelitic metasedimentary rocks. Note cordierite rims on early, rounded andalusite porphyroblasts. No rims on late, large andalusite porphyroblasts. The scale card at base of photo has centimetre divisions. ii) Inclusion-rich core of staurolite porphyroblast preserves an S_1 fabric by aligned, elongate quartz inclusions. The outer region of porphyroblast overgrows the fabric of the groundmass. Groundmass preserves an S_1 cleavage crenulated by S_2 (indicated). Photo taken in cross-polarised light, scale bar is approximately 5 millimetres long.

Figure 9. P-T History of the Aylmer Lake Volcanic Belt. Schematic topology of KFMASH univariant reactions (thin dashed lines) and divariant Fe + Mg

exchange reactions (grey shading). Aylmer Lake Volcanic Belt area P-T loop in thick dashed line. (A) early (M_1) staurolite and andalusite porphyroblasts (post D_1). (B) andalusite growth due to decompression. (C) formation of sillimanite haloes on staurolite and andalusite porphyroblasts due to increased thermal regime. (D) growth of late to post D_2, peak M_2 cordierite porphyroblasts. E) Growth of late, euhedral staurolite overgrowths on cordierite. Topology after (Pattison et al., 1999). Compare with figure 7c.

Figure 10. Representative garnet zoning profiles and back-scatter electron microprobe images in garnets from low, medium and high grade area. A) Sample 0293 collected just above cordierite in isograd. B) Sample 0383 collected from cordierite zone, just below sillimanite-in isograd. Note the retrograde elemental zonation extends almost 150um from the rim. C) Sample 2133 collected well above melt-in isograd. Elemental profiles of sample 2133 are interpreted with respect to garnet characteristics. Inclusion-rich core grew syn-D_2, evidenced by bent inclusion trails (indicated on figure). Less inclusion rich rim grew syn D_3, elemental profiles in rim are compatible with growth during heating and decompression. Thick bars indicate compositional analysis used for thermobarometric calculations, selected as close to the rim as possible to eliminate retrograde Mg and Fe re-equilibration. Bars labeled transect on backscatter images show approximate locations of microprobe analyses. See text for explanation.

Figure 12. A family of P-T loops for the Walmsley lake area. Loops are constrained for various geographic areas of the upper and lower lithotectonic domains. Relative and absolute timing of metamorphic events are indicated. Numbered points indicate peak metamorphic conditions of individual samples from thermobarometry; each point represents the maximum metamorphic conditions for that sample, corresponding to the apex of a P-T-t loop of similar topology to the generalized loops indicated. The general morphology of the loops is deduced from porphyroblast-fabric relationships (see text).

Figure 12. Thermobarometry plots of independent reactions for cordierite + garnet + biotite + plagioclase bearing samples (TWQ ver. 2.02b). The calculation uses the mixing solutions of Fuhrman and Lindsey (1988) for plagioclase, and Berman and Anarovich (1996a) for garnet, cordierite and biotite. Samples 287 and 2133 are from the upper and lower tectonothermal domains respectively Note that the same set of mineral equilibria indicate a systematic difference in pressure and temperature across the domains.

Figure 13. Schematic diagram illustrating timing of plutonism, deformation and crustal thermal evolution during two stages of crustal thickening in upper and lower lithotectonic domains, and subsequent extensional decoupling and collapse of over-thickened crust in lower lithotectonic domain (see text). Sources of geochronological data: Circles, this study, diamonds compiled from: 1- van Breeman et al., 1987, 2- van Breeman and Henderson, 1988, 3- Macfie et al.,

1990, 4- Frith et al., 1991, 5-Henderson and van Breeman, 1992; 6 - Schultz, 2002 source 6 is a statistical chemical date of monazite by electron microprobe.

Figure 14. Cartoon cross-sections of the geological evolution of the Walmsley Lake area. A) A succession of ca. 2.68 – 2.64 Ga supracrustal rocks develop a small juvenile craton. B) Collision of the juvenile craton with the Mesoarchean basement of the western Slave province results in crustal thickening through vertical isoclinal folding of the crust (D_1, D_2). Defeat-like (syn-D_2) and prosperous-like (post-D_2) plutons are intruded at this time. C) Radiogenic heat build up in orogenically thickened crust results in widespread crustal melting at mid-crustal levels. The melt production hastens the gravitational collapse of the orogen (D_3). Depressurization during gravitational collapse causes further melting with lateral flow of melt products. D) Present day erosional surface showing upper tectonothermal domain with upright structures, lower tectonothermal domain with sub horizontal structures, and the transition zone.

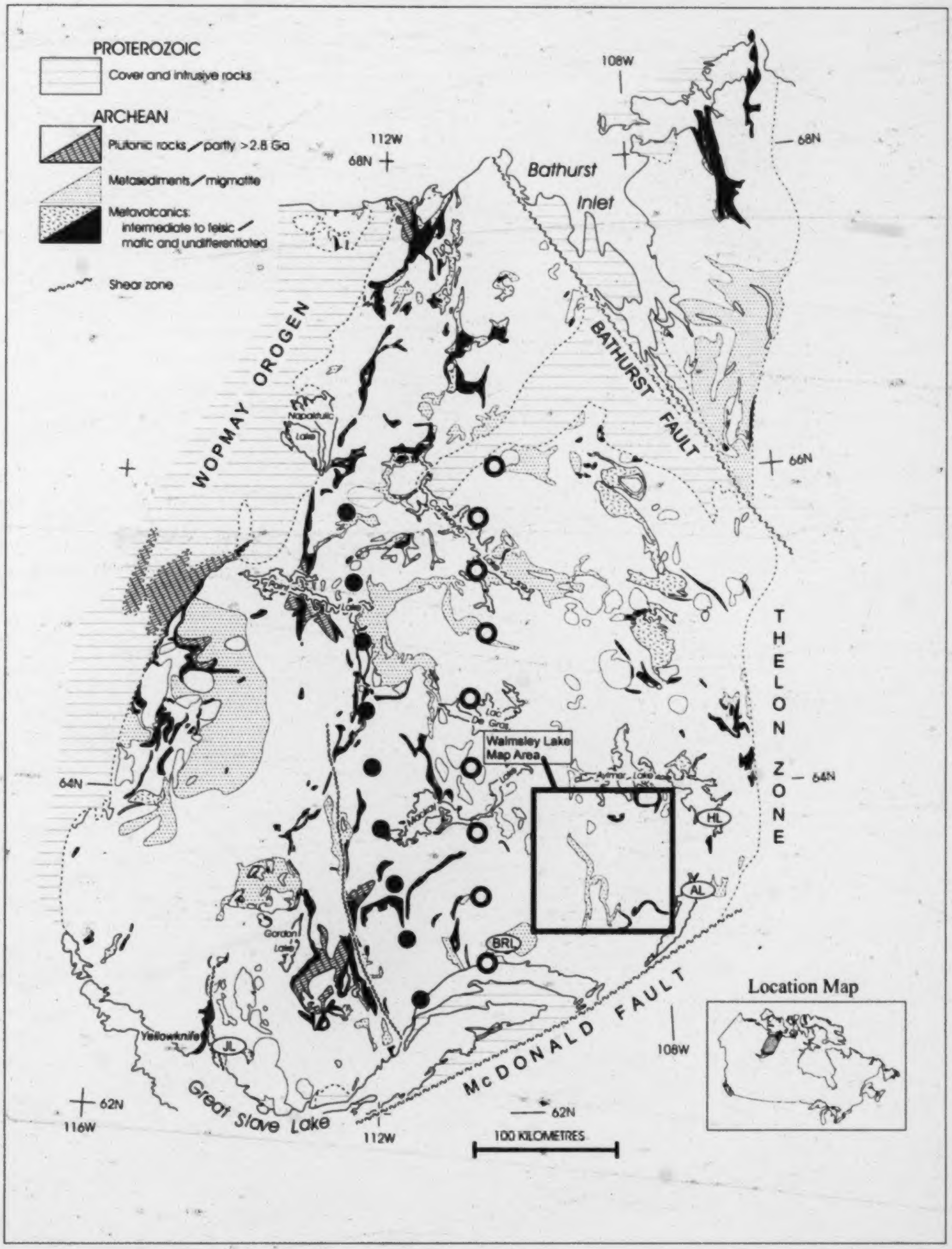
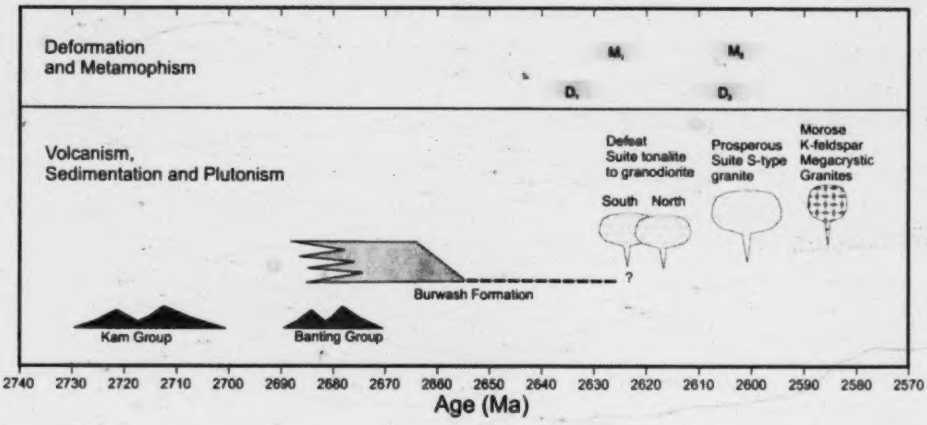

PROTEROZOIC
Cover and intrusive rocks
ARCHEAN
Plutonic rocks / partly >2.8 Ga
Metasediments / migmatite
Metavolcanics: intermediate to felsic / mafic and undifferentiated
Shear zone
108W
112W
68N
68N
Bathurst
Inlet
BATHURST FAULT
WOPMAY OROGEN
Napaktulik Lake
66N
THELON ZONE
Lac De Gras
Walmsley Lake Map Area
Aylmer Lake
64N
64N
HL
AL
BRL
Gordon Lake
Yellowknife
JL
Great Slave Lake
McDONALD FAULT
Location Map
108W
116W
62N
112W
62N
100 KILOMETRES

Figure 1

Figure 2


Deformation
and Metamophism
M_1
M_2
D_1
D_2
Volcanism,
Sedimentation and Plutonism
Defeat
Suite tonalite
to granodiorite
South
North
Prosperous
Suite S-type
granite
Morose
K-feldspar
Megacrystic
Granites
?
Burwash Formation
Kam Group
Banting Group
2740
2730
2720
2710
2700
2690
2680
2670
2660
2650
2640
2630
2620
2610
2600
2590
2580
2570
Age (Ma)

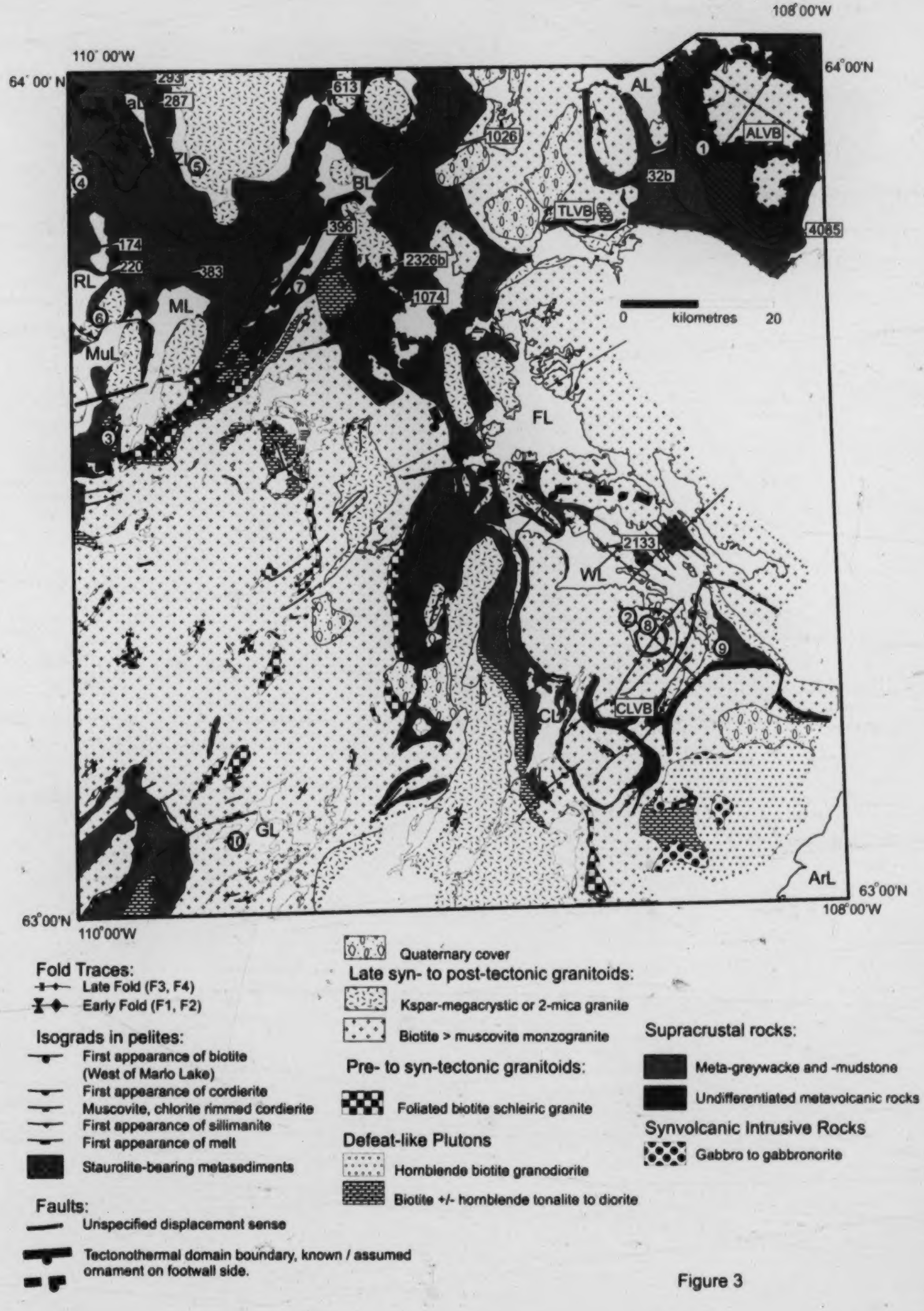

108°00'W
110° 00'W
64° 00' N
64°00'N
293
287
613
1026
AL
ALVB
1
32b
4085
TLVB
BL
396
2326b
1074
ZI
5
4
174
220
383
RL
6
7
ML
MuL
3
0
kilometres
20
FL
2133
WL
2
8
9
CL
CLVB
GL
10
ArL
63°00'N
108°00'W
63°00'N
110°00'W
Fold Traces:
Late Fold (F3, F4)
Early Fold (F1, F2)
Isograds in pelites:
First appearance of biotite (West of Mario Lake)
First appearance of cordierite
Muscovite, chlorite rimmed cordierite
First appearance of sillimanite
First appearance of melt
Staurolite-bearing metasediments
Faults:
Unspecified displacement sense
Tectonothermal domain boundary, known / assumed ornament on footwall side.
Quaternary cover
Late syn- to post-tectonic granitoids:
Kspar-megacrystic or 2-mica granite
Biotite > muscovite monzogranite
Pre- to syn-tectonic granitoids:
Foliated biotite schleiric granite
Defeat-like Plutons
Hornblende biotite granodiorite
Biotite +/- hornblende tonalite to diorite
Supracrustal rocks:
Meta-greywacke and -mudstone
Undifferentiated metavolcanic rocks
Synvolcanic Intrusive Rocks
Gabbro to gabbronorite

Figure 3

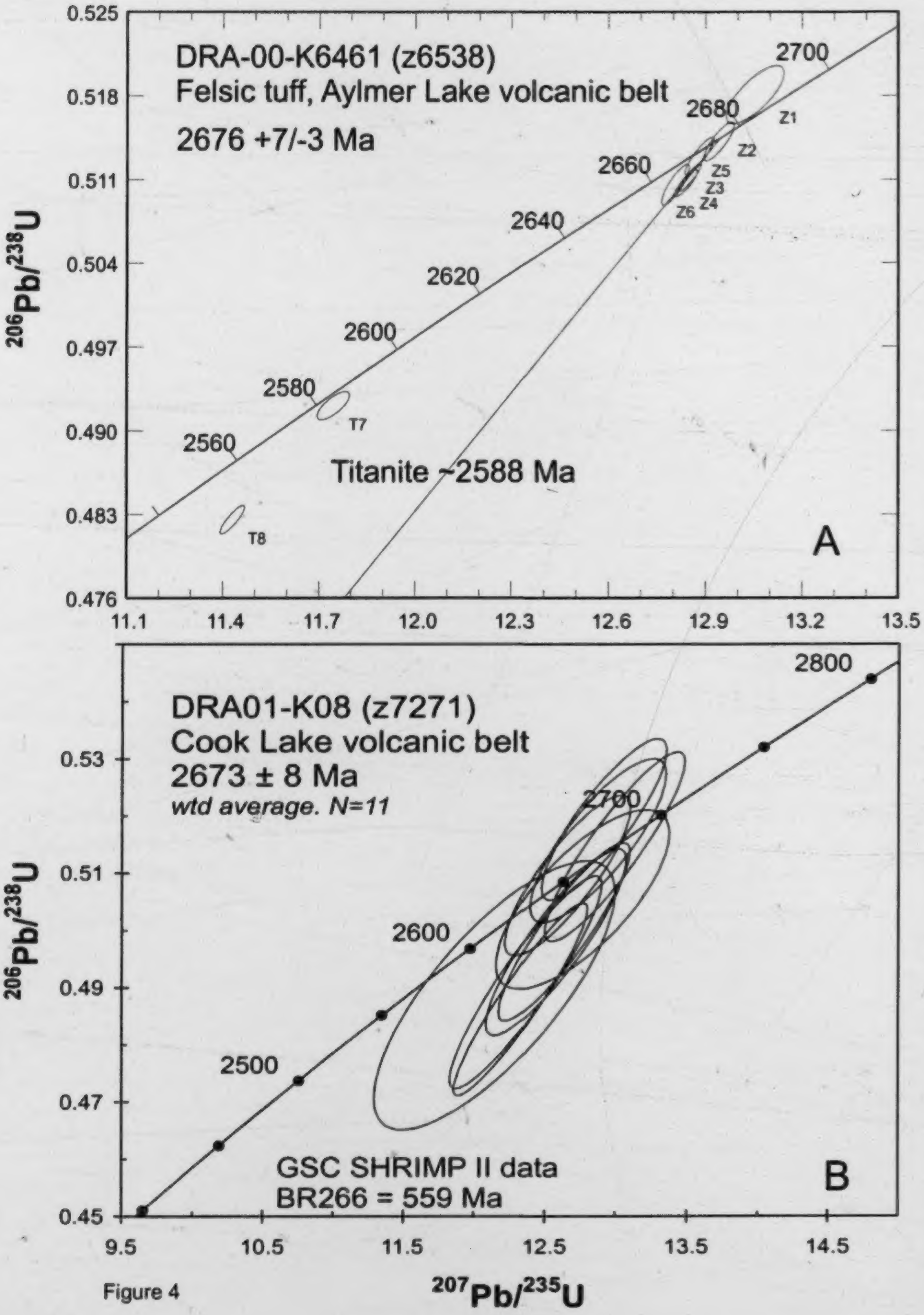

DRA-00-K6461 (z6538)
Felsic tuff, Aylmer Lake volcanic belt
2676 +7/-3 Ma
2700
2680
2660
2640
2620
2600
2580
2560
Z1
Z2
Z5
Z3
Z4
Z6
T7
T8
Titanite ~2588 Ma
A
$^{206}Pb/^{238}U$
0.525
0.518
0.511
0.504
0.497
0.490
0.483
0.476
11.1
11.4
11.7
12.0
12.3
12.6
12.9
13.2
13.5
DRA01-K08 (z7271)
Cook Lake volcanic belt
2673 ± 8 Ma
wtd average. N=11
2800
2700
2600
2500
GSC SHRIMP II data
BR266 = 559 Ma
B
$^{206}Pb/^{238}U$
0.53
0.51
0.49
0.47
0.45
9.5
10.5
11.5
12.5
13.5
14.5
$^{207}Pb/^{235}U$

Figure 4

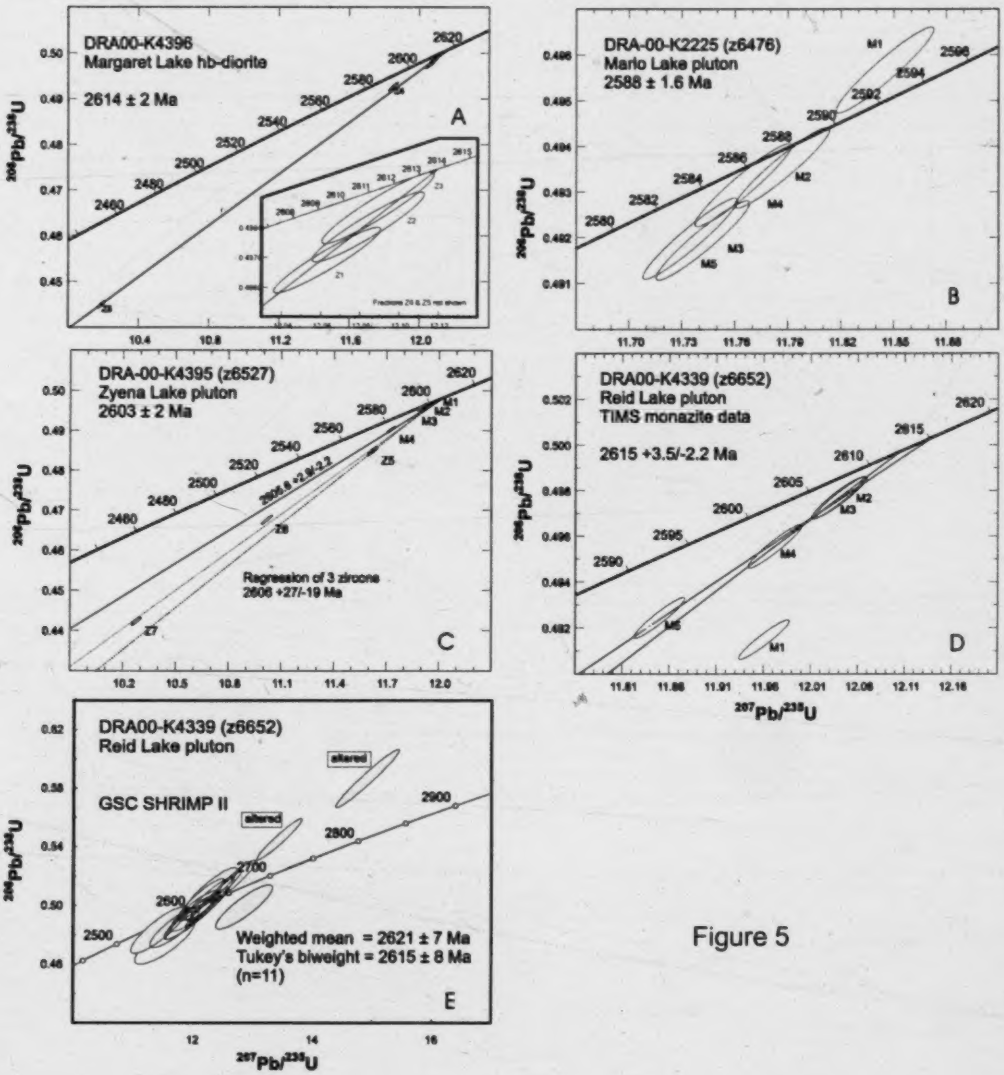

DRA00-K4396
Margaret Lake hb-diorite
2614 ± 2 Ma
A
Fractions Z4 & Z5 not shown
DRA-00-K2225 (z6476)
Mario Lake pluton
2588 ± 1.6 Ma
B
M1
M2
M3
M4
M5
DRA-00-K4395 (z6527)
Zyena Lake pluton
2603 ± 2 Ma
Regression of 3 zircons
2606 +27/-19 Ma
2606.8 +2.9/-2.2
C
Z5
Z6
Z7
DRA00-K4339 (z6652)
Reid Lake pluton
TIMS monazite data
2615 +3.5/-2.2 Ma
D
DRA00-K4339 (z6652)
Reid Lake pluton
GSC SHRIMP II
altered
altered
Weighted mean = 2621 ± 7 Ma
Tukey's biweight = 2615 ± 8 Ma
(n=11)
E
$^{206}Pb/^{238}U$
$^{207}Pb/^{235}U$

Figure 5

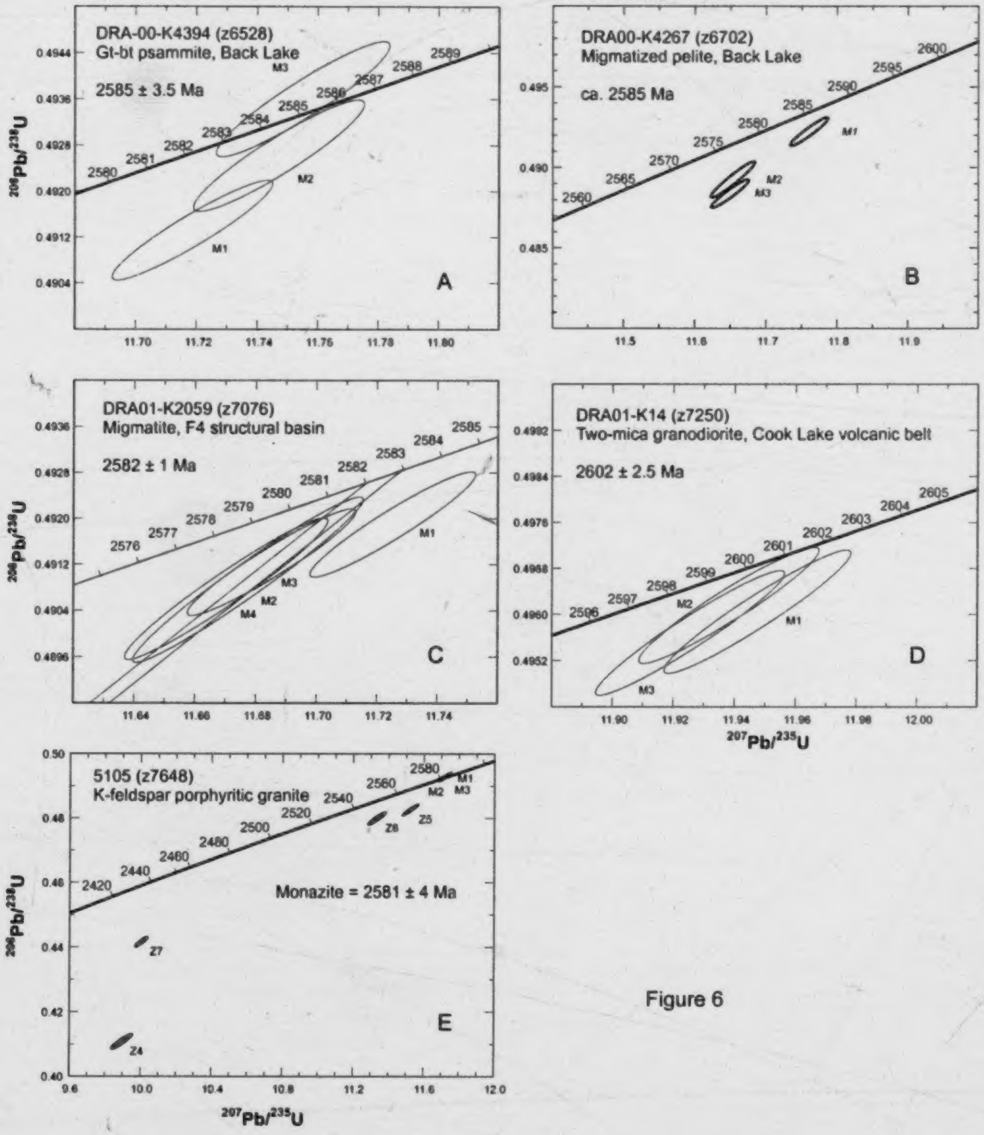

DRA-00-K4394 (z6528)
Gt-bt psammite, Back Lake
2585 ± 3.5 Ma
2580
2581
2582
2583
2584
2585
2586
2587
2588
2589
M1
M2
M3
A
0.4944
0.4936
0.4928
0.4920
0.4912
0.4904
11.70
11.72
11.74
11.76
11.78
11.80
^{206}Pb/^{238}U
DRA00-K4267 (z6702)
Migmatized pelite, Back Lake
ca. 2585 Ma
2560
2565
2570
2575
2580
2585
2590
2595
2600
M1
M2
M3
B
0.495
0.490
0.485
11.5
11.6
11.7
11.8
11.9
DRA01-K2059 (z7076)
Migmatite, F4 structural basin
2582 ± 1 Ma
2576
2577
2578
2579
2580
2581
2582
2583
2584
2585
M1
M2
M3
M4
C
0.4936
0.4928
0.4920
0.4912
0.4904
0.4896
11.64
11.66
11.68
11.70
11.72
11.74
^{206}Pb/^{238}U
DRA01-K14 (z7250)
Two-mica granodiorite, Cook Lake volcanic belt
2602 ± 2.5 Ma
2596
2597
2598
2599
2600
2601
2602
2603
2604
2605
M1
M2
M3
D
0.4992
0.4984
0.4976
0.4968
0.4960
0.4952
11.90
11.92
11.94
11.96
11.98
12.00
^{207}Pb/^{235}U
5105 (z7648)
K-feldspar porphyritic granite
Monazite = 2581 ± 4 Ma
2420
2440
2460
2480
2500
2520
2540
2560
2580
M1
M2
M3
Z4
Z5
Z7
Z8
E
0.50
0.48
0.46
0.44
0.42
0.40
9.6
10.0
10.4
10.8
11.2
11.6
12.0
^{206}Pb/^{238}U
^{207}Pb/^{235}U

Figure 6

Figure 7

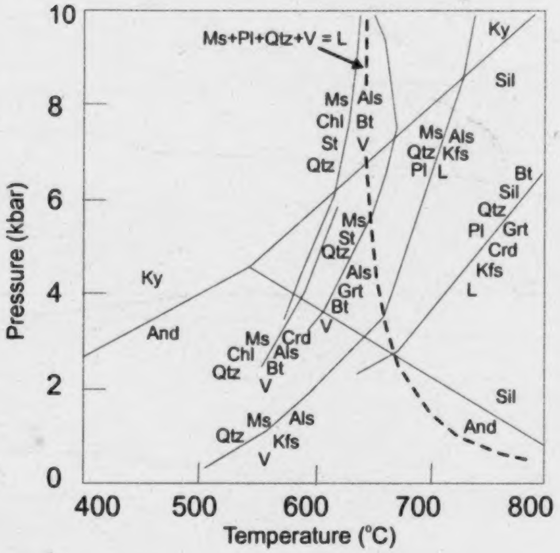

Ms+Pl+Qtz+V = L
Ms
Chl
St
Qtz
Als
Bt
V
Ms
Qtz
Pl
Als
Kfs
L
Ky
Sil
Bt
Sil
Qtz
Pl
Grt
Crd
Kfs
L
Ms
St
Qtz
Als
Grt
Bt
V
Ky
And
Ms
Chl
Qtz
Crd
Als
Bt
V
Ms
Qtz
Als
Kfs
V
Sil
And
Pressure (kbar)
0
2
4
6
8
10
400
500
600
700
800
Temperature (°C)

Figure 8

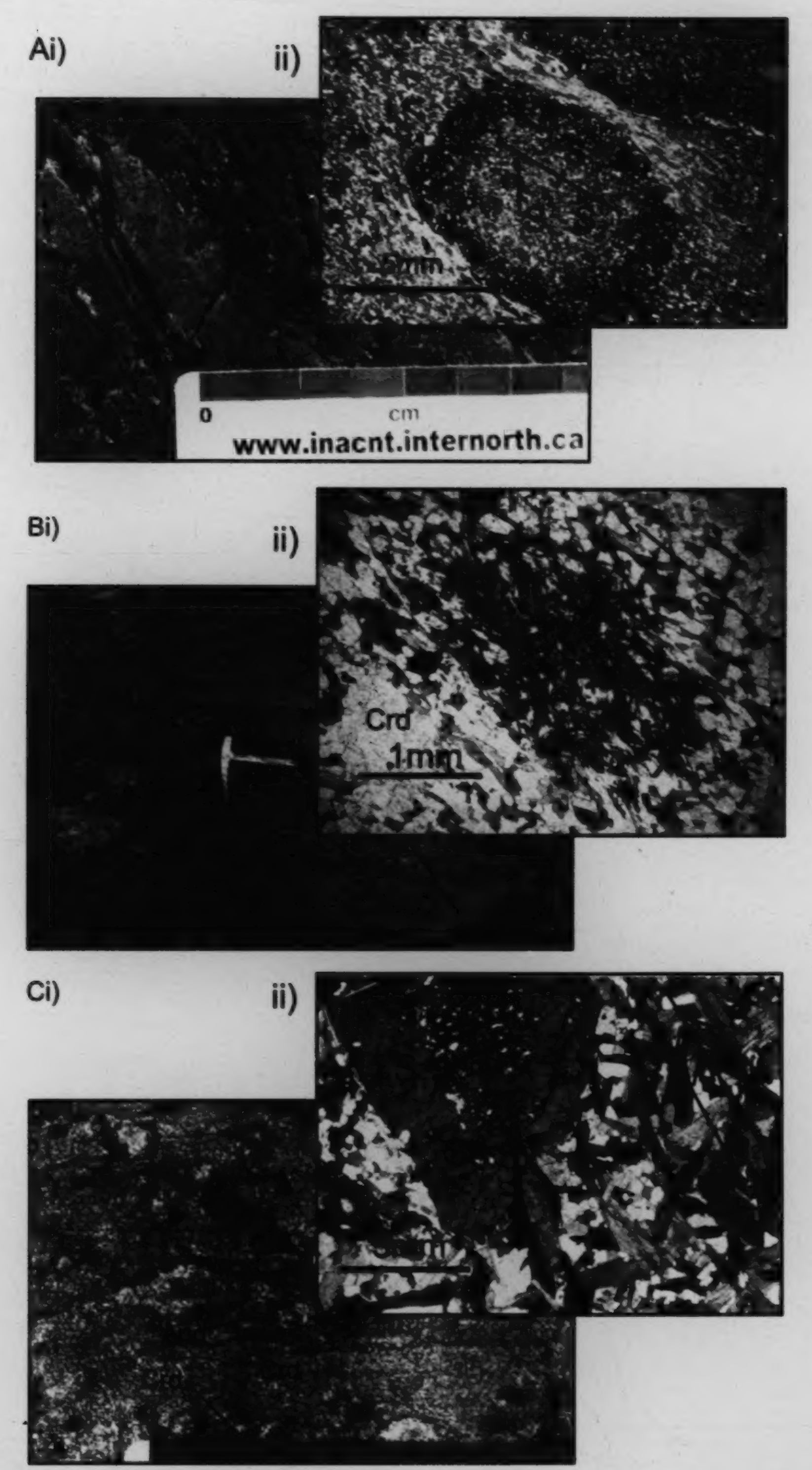

Ai)
ii)
2mm
0
cm
www.inacnt.internorth.ca
Bi)
ii)
Crd
1mm
Ci)
ii)

Figure 9

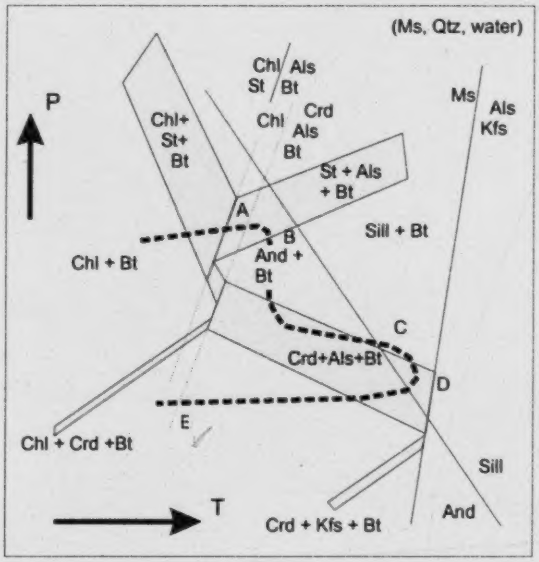

(Ms, Qtz, water)
Chl
St
Als
Bt
P
Chl+
St+
Bt
Chl
Crd
Als
Bt
Ms
Als
Kfs
St + Als
+ Bt
A
B
Sill + Bt
Chl + Bt
And +
Bt
C
Crd+Als+Bt
D
E
Chl + Crd +Bt
Sill
T
Crd + Kfs + Bt
And

Figure 10

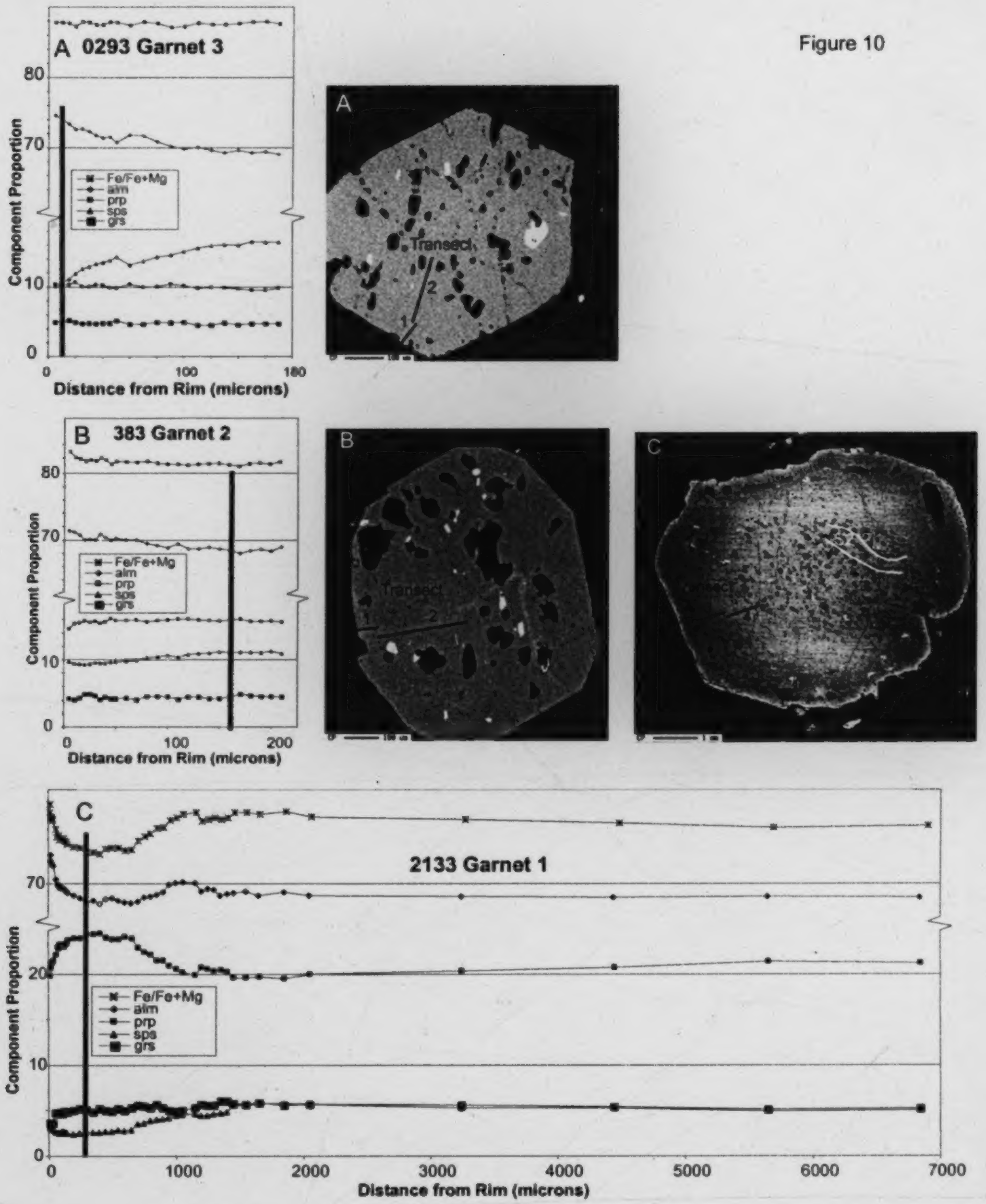

A 0293 Garnet 3
Component Proportion
Distance from Rim (microns)
Fe/Fe+Mg
alm
prp
sps
grs
0
10
70
80
0
100
180
A
Transect
1
2
B 383 Garnet 2
Component Proportion
Distance from Rim (microns)
Fe/Fe+Mg
alm
prp
sps
grs
0
10
70
80
0
100
200
B
Transect
1
2
C
C
2133 Garnet 1
Component Proportion
Distance from Rim (microns)
Fe/Fe+Mg
alm
prp
sps
grs
0
10
20
70
0
1000
2000
3000
4000
5000
6000
7000

Figure 11

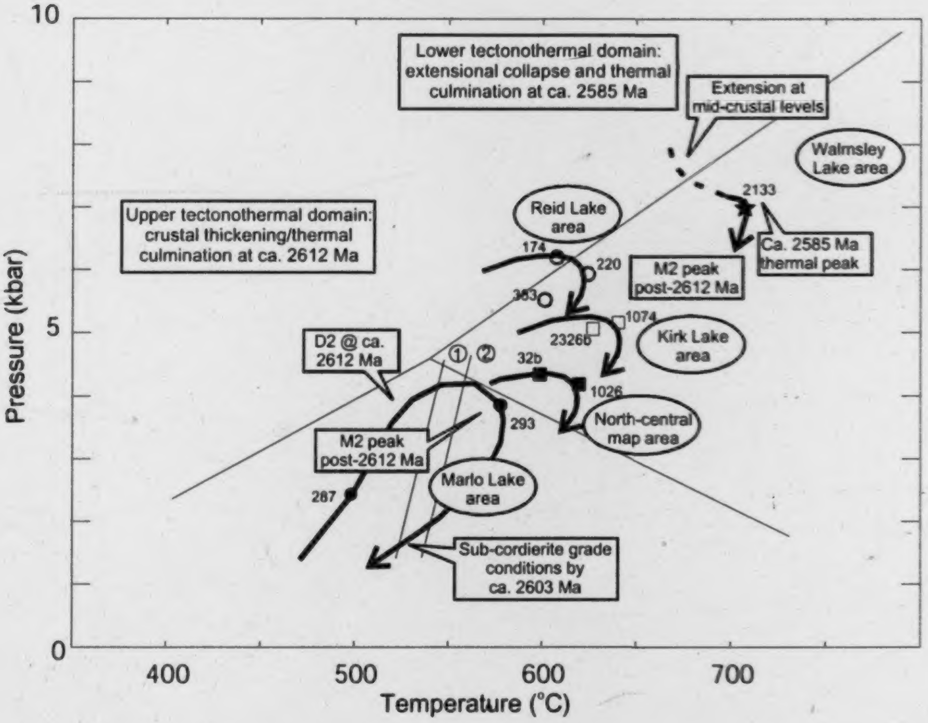
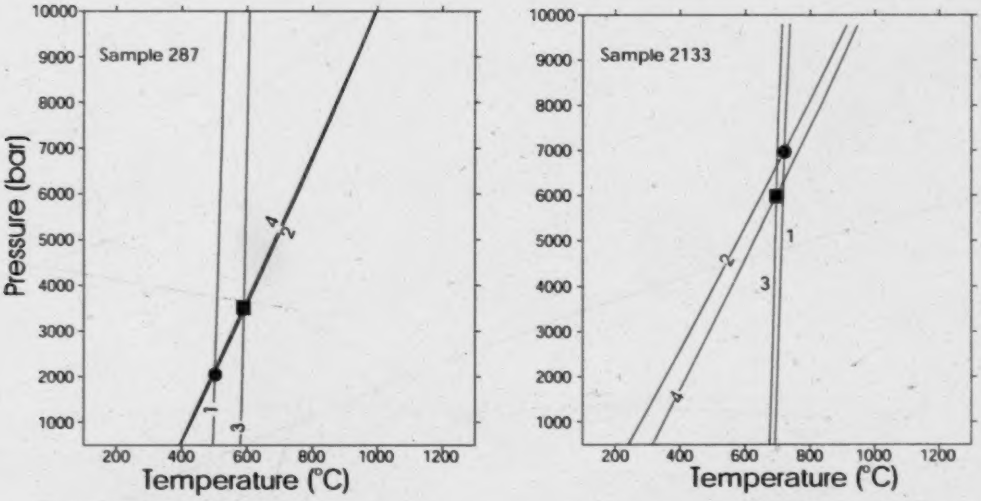

10
5
0
Pressure (kbar)
400
500
600
700
Temperature (°C)
Lower tectonothermal domain: extensional collapse and thermal culmination at ca. 2585 Ma
Extension at mid-crustal levels
Walmsley Lake area
2133
Ca. 2585 Ma thermal peak
M2 peak post-2612 Ma
Upper tectonothermal domain: crustal thickening/thermal culmination at ca. 2612 Ma
Reid Lake area
174
220
353
1074
23266
Kirk Lake area
D2 @ ca. 2612 Ma
①
②
32b
1026
293
North-central map area
M2 peak post-2612 Ma
Marlo Lake area
287
Sub-cordierite grade conditions by ca. 2603 Ma

Figure 12



4 Independant Reactions

1) Phlogopite + Almandine ⇌ Annite + Pyrope
2) 4 Sillimanite + Quartz + Grossular ⇌ 3 Anorthite
3) 2 Almandine + 3 Cordierite ⇌ 2 Pyrope + 3 Fe-Cordierite
4) 4 Sillimanite + 5 Quartz + 2 Almandine ⇌ 3 Fe-Cordieitie

● Intersection using GARB and GASP equilibria, reactions 1 and 2 respectively.

■ Intersection of Fe-Mg exchange between cordierite and garnet with cordierite decomposition equilibria, reactions 3 and 4 respectively.

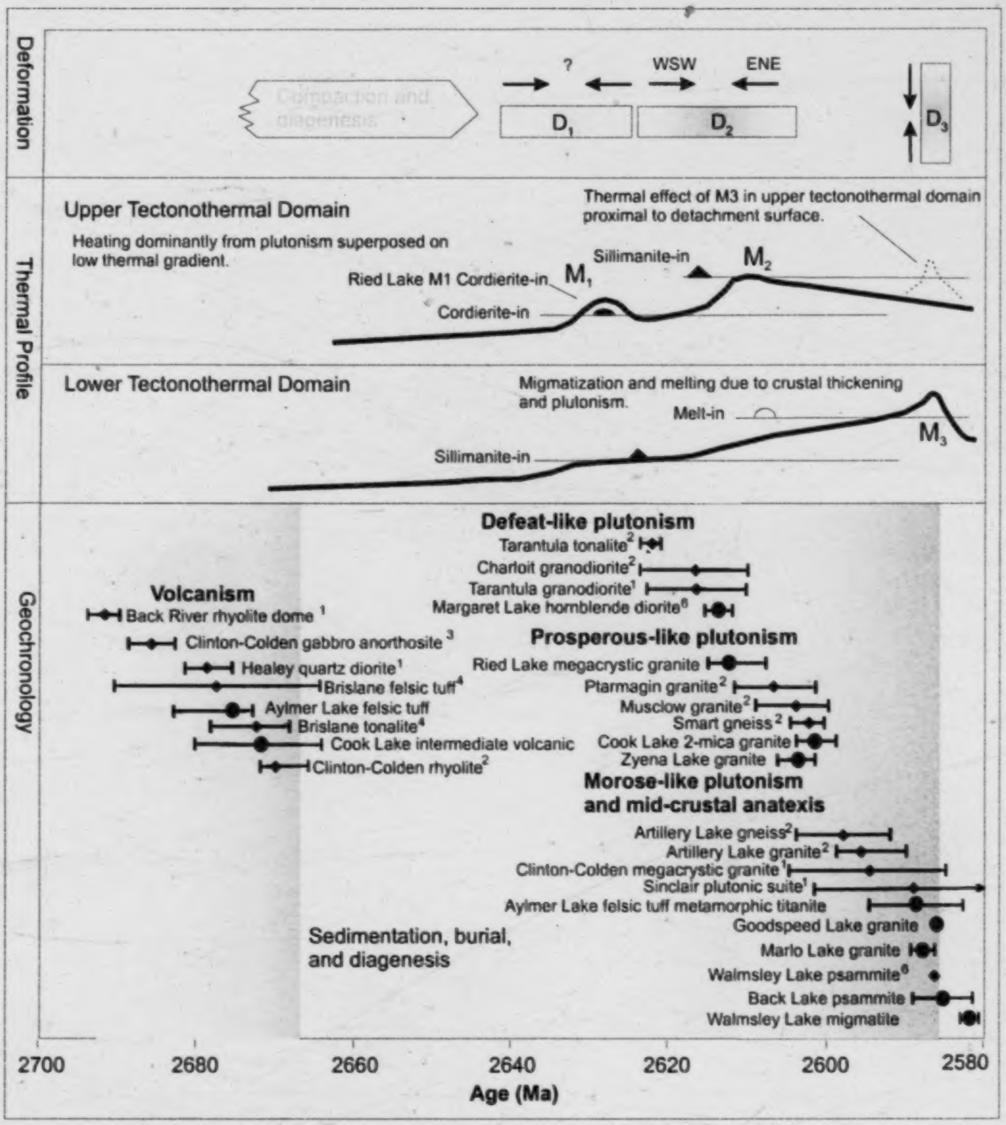
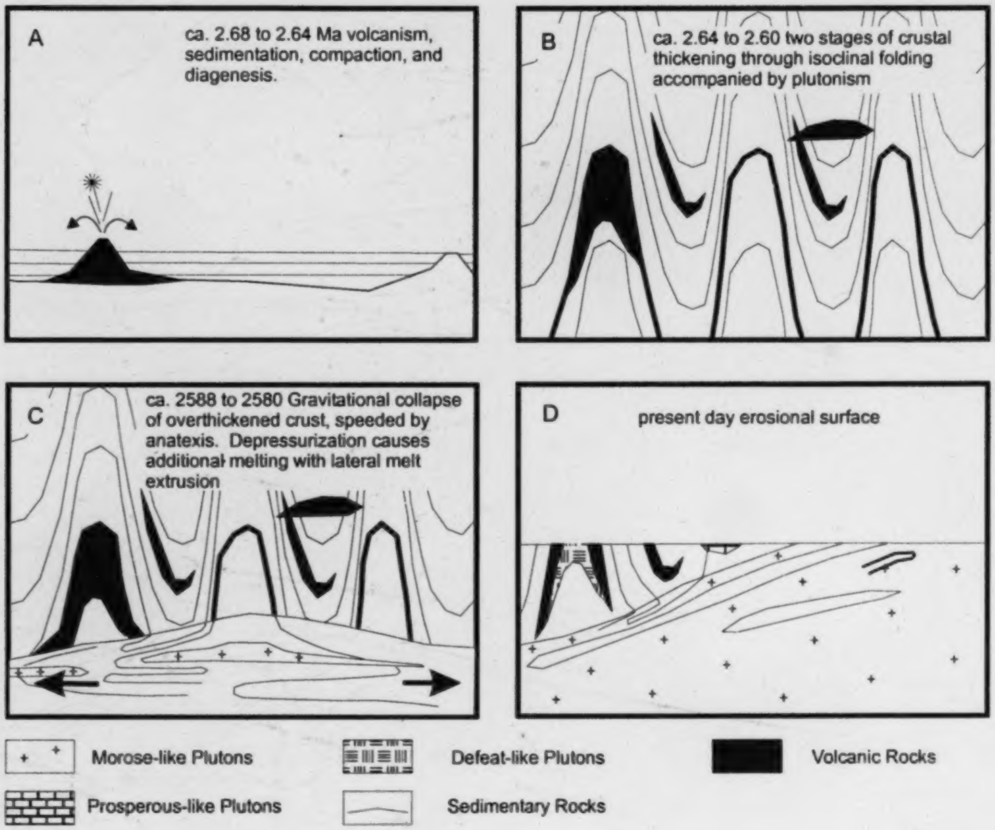

Deformation
Compaction and diagenesis
?
WSW
ENE
D1
D2
D3
Thermal Profile
Upper Tectonothermal Domain
Heating dominantly from plutonism superposed on low thermal gradient.
Thermal effect of M3 in upper tectonothermal domain proximal to detachment surface.
Sillimanite-in
M2
Ried Lake M1 Cordierite-in
M1
Cordierite-in
Lower Tectonothermal Domain
Migmatization and melting due to crustal thickening and plutonism.
Melt-in
M3
Sillimanite-in
Geochronology
Defeat-like plutonism
Tarantula tonalite2
Charloit granodiorite2
Tarantula granodiorite1
Margaret Lake hornblende diorite6
Volcanism
Back River rhyolite dome 1
Clinton-Colden gabbro anorthosite 3
Healey quartz diorite1
Brislane felsic tuff4
Aylmer Lake felsic tuff
Brislane tonalite4
Cook Lake intermediate volcanic
Clinton-Colden rhyolite2
Prosperous-like plutonism
Ried Lake megacrystic granite
Ptarmagin granite2
Musclow granite2
Smart gneiss 2
Cook Lake 2-mica granite
Zyena Lake granite
Morose-like plutonism and mid-crustal anatexis
Artillery Lake gneiss2
Artillery Lake granite2
Clinton-Colden megacrystic granite1
Sinclair plutonic suite1
Aylmer Lake felsic tuff metamorphic titanite
Goodspeed Lake granite
Marlo Lake granite
Walmsley Lake psammite6
Back Lake psammite
Walmsley Lake migmatite
Sedimentation, burial, and diagenesis
2700
2680
2660
2640
2620
2600
2580
Age (Ma)

Figure 13

Figure 14


A
B
C
D
Morose-like Plutons
Defeat-like Plutons
Volcanic Rocks
Prosperous-like Plutons
Sedimentary Rocks

A ca. 2.68 to 2.64 Ma volcanism, sedimentation, compaction, and diagenesis.

B ca. 2.64 to 2.60 two stages of crustal thickening through isoclinal folding accompanied by plutonism

C ca. 2588 to 2580 Gravitational collapse of overthickened crust, speeded by anatexis. Depressurization causes additional melting with lateral melt extrusion

D present day erosional surface

Table 1. U/Pb TIMS data

Fraction[1]	Description**	Wt. ug	U^{a} ppm	Pb^{a*} ppm	^{206}Pb/^{204}Pb^{c}	Pb^{c} pg	^{208}Pb*/^{206}Pb	^{206}Pb/^{238}U^{2}	±1 SE	^{207}Pb/^{235}U^{2}	±1 SE	^{207}Pb/^{206}Pb^{2}	±1 SE	Apparent Age (Ma) ^{206}Pb/^{238}U	Apparent Age (Ma) ^{207}Pb/^{206}Pb	+/-^{3}	% Disc
DRA-00-K6461 Aylmer Lake volcanic belt (Z6538; 63.9263°N 108.3448°E)																	
Z1	3,150,Z,Co,Clr,fdIn,oIn,El,Pr,Abr,M1°	8	42	25	343	33	0.14	0.51810	0.00121	13.053	0.045	0.18273	0.00042	2691.1	2677.8	7.5	-0.61
Z2	3,100,Z,Co,Clr,fFr,fIn,Pr,Abr,M3°	6	67	38	1828	8	0.11	0.51419	0.00082	12.941	0.024	0.18253	0.00018	2674.5	2676.0	3.2	0.07
Z3	6,100,Z, pBr,Clr,fdIn,oIn,Pr,Abr,M1°	10	42	24	5141	3	0.12	0.51118	0.00068	12.852	0.017	0.18234	0.00009	2661.7	2674.3	1.7	0.58
Z4	10,75,Z,Co,Clr,fdIn,oIn,Pr,Abr,M1°	8	51	29	4334	3	0.12	0.51073	0.00058	12.839	0.018	0.18232	0.00012	2659.8	2674.1	2.2	0.66
Z5	3,200,Z,Co,Clr,fdIn,oIn,El,Pr,Abr,M1°	11	30	17	1284	8	0.13	0.51296	0.00080	12.880	0.023	0.18211	0.00014	2669.2	2672.1	2.6	0.13
Z6	6,100,Z,Co,Clr,fFr,fIn,El,Pr,Abr,NM3°	6	61	35	1626	7	0.13	0.51057	0.00086	12.806	0.022	0.18191	0.00017	2659.1	2670.4	3.1	0.52
T7	18,200,T,pBr,Clr,An,NAbr,M-1A	65	24	12	517	93	0.07	0.49211	0.00059	11.744	0.026	0.17308	0.00026	2579.8	2587.7	5.1	0.37
T8	40,250,T,pBr,Clr,An,NAbr,M-1A	248	37	19	1140	244	0.05	0.48257	0.00060	11.430	0.019	0.17179	0.00014	2538.4	2575.1	2.8	1.72
DRA01-K14 Cook Lake granodiorite (Z7290; 63.2963°N 108.3519°E)																	
M1	1,150,M,pY,Clr,Eu,NAbr,M-0.5A	2	4368	3835	103469	3	0.68	0.49605	0.00053	11.948	0.015	0.17468	0.00007	2596.8	2603.0	1.4	0.29
M2	1,200,M,Co,Clr,Sub,NAbr,M-0.5A	6	3939	10965	92818	8	5.3	0.49616	0.00051	11.938	0.015	0.17451	0.00007	2597.3	2601.3	1.4	0.19
M3	1,300,M,Co,Clr,Sub,NAbr,M-0.5A	11	2365	9834	74848	11	8.51	0.49568	0.00054	11.925	0.016	0.17449	0.00007	2595.2	2601.2	1.4	0.28
DRA-00-K2225 Mario Lake Pluton (Z6476; 63.7221°N 109.9881°E)																	
M1	1,75,M,pY,Clr,Eu,Tab,Abr,M-0.5A	2	3E+05	180266	280094	5	0.31	0.49567	0.00047	11.845	0.014	0.17332	0.00007	2595.2	2589.9	1.4	-0.25
M2	1,100,M,pY,Clr,Eu,Tab,Abr,M-0.5A	3	9831	8766	294977	3	0.92	0.49353	0.00044	11.787	0.013	0.17321	0.00007	2585.9	2588.9	1.4	0.14
M3	1,75,M,Co,Clr,Eu,Tab,Abr,M-0.5A	1	14654	12484	201566	3	0.83	0.49194	0.00044	11.742	0.013	0.17311	0.00007	2579.1	2588.0	1.4	0.42
M4	1,125,M,pY,Clr,Eu,Tab,Abr,M-0.5A	4	20128	17521	552300	4	0.87	0.49315	0.00046	11.765	0.014	0.17302	0.00007	2584.3	2587.1	1.4	0.13
M5	1,100,M,pY,Clr,Eu,Tab,Abr,M-0.5A	2	15727	14048	232945	4	0.93	0.49198	0.00044	11.735	0.013	0.17299	0.00007	2579.2	2586.8	1.4	0.36
DRA-00-K4385 Zyena Lake Pluton (Z6527; 63.9025°N 109.6784°E)																	
M1	4,50,M,pY,Clr,Eu,Sub,Abr,M-0.5A	4	1231	4207	28446	3	6.76	0.49683	0.00043	11.969	0.013	0.17472	0.00007	2600.2	2603.4	1.4	0.15
M2	1,100,M,pY,Alt,Fg,NAbr,M-0.5A	2	1033	4017	14906	4	7.88	0.49572	0.00045	11.927	0.014	0.17450	0.00008	2595.4	2601.3	1.4	0.28
M3	1,50,M,pY,Clr,Sub,Abr,M-0.5A	1	452	1933	7848	2	8.77	0.49583	0.00053	11.904	0.015	0.17413	0.00007	2595.8	2597.7	1.8	0.09
M4	1,50,M,dY,Clr,Eu,Nabr,M-0.5A	1	4693	10161	29729	5	3.93	0.49018	0.00044	11.725	0.013	0.17348	0.00007	2571.4	2591.5	1.4	0.94
Z5	6,100,Z,Br,Clr,fFr,fIn,El,Pr,Abr,M3°	8	177	101	4600	9	0.19	0.48484	0.00055	11.622	0.016	0.17385	0.00008	2548.3	2595.1	1.6	2.18
Z6	4,150,Z,Br,Clr,fFr,fIn,Pr,Tab,Abr,M3°	8	577	292	7892	17	0.09	0.46762	0.00058	11.018	0.016	0.17089	0.00008	2473.1	2566.4	1.5	4.37
Z7	4,150,Z,Br,Clr,fFr,fIn,El,Pr,Abr,M3°	8	284	147	2511	25	0.19	0.44227	0.00051	10.277	0.015	0.16853	0.00009	2360.8	2543.1	1.9	8.55
DRA-00-K4339 Reid Lake Granite (Z6652; 63.7412°N 109.8775°E)																	
M1	1,100,M,Y,Clr,fFr,fIn,Fg,Abr,M-0.5A	9	1015	4725	19336	14	9.75	0.49149	0.00043	11.961	0.014	0.17650	0.00007	2577.1	2620.2	1.4	1.99
M2	1,100,M,Y,Clr,fFr,fIn,Fg,Abr,M-0.5A	2	3385	3801	74134	3	1.44	0.49772	0.00045	12.043	0.014	0.17547	0.00007	2604.0	2610.5	1.4	0.3
M3	1,100,M,Y,Clr,fFr,fIn,Fg,Abr,M-0.5A	2	2038	2715	64345	1	1.92	0.49767	0.00046	12.039	0.014	0.17544	0.00007	2603.8	2610.3	1.4	0.3
M4	1,125,M,Y,Clr,fFr,fIn,Fg,Abr,M-0.5A	5	1088	1782	32725	6	1.29	0.49555	0.00047	11.972	0.014	0.17522	0.00007	2594.7	2608.1	1.4	0.63
M5	1,100,M,Co,Clr,fFr,fIn,Fg,Abr,M-0.5A	3	2512	3960	48164	5	2.53	0.49244	0.00044	11.847	0.014	0.17452	0.00007	2581.2	2601.5	1.4	0.95
DRA-00-K4386 Margaret Lake hornblende diorite (Z6536; 63.5937°N 109.9124°E)																	
Z1	6,125,Z,pBr,Clr,fdIn,oIn,Pr,Abr,Dia	23	132	76	24444	4	0.17	0.49753	0.00044	12.063	0.014	0.17585	0.00007	2603.2	2614.1	1.4	0.51
Z2	5,125,Z,pBr,Clr,fdIn,oIn,Pr,Abr,Dia	24	80	46	6047	10	0.18	0.49842	0.00047	12.084	0.014	0.17584	0.00008	2607.0	2614.0	1.5	0.33
Z3	9,100,Z,pBr,Clr,fdIn,oIn,Pr,Abr,Dia	19	103	60	12597	5	0.17	0.49893	0.00048	12.069	0.014	0.17573	0.00008	2609.2	2613.0	1.4	0.18
Z4	6,125,Z,pBr,Clr,fIn,Pr,St,Abr,NM0°	15	148	82	5704	12	0.14	0.49269	0.00050	11.853	0.015	0.17448	0.00008	2582.3	2601.1	1.5	0.87
Z5	14,125,Z,pBr,Clr,fFr,Ndl,NAbr,NM0°	5	370	181	3404	15	0.11	0.44499	0.00042	10.190	0.012	0.16607	0.00008	2373.0	2518.5	1.7	6.9
DRA-00-K4394 Back Lake psammite (Z6528; 63.7336°N 109.4464°E)																	
M1	2,75,M,pY,Clr,fIn,Eu,Sub,Abr,M-0.5A	2	2102	5387	10241	10	4.85	0.49132	0.00043	11.719	0.013	0.17299	0.00008	2576.4	2586.8	1.5	0.49
M2	3,50,M,pY,Clr,fIn,Eu,Sub,Abr,M-0.5A	1	486	1262	11546	2	4.92	0.49262	0.00048	11.747	0.014	0.17295	0.00008	2582.0	2586.4	1.6	0.21
M3	4,75,M,pY,Clr,fIn,Eu,Sub,Abr,M-0.5A	2	634	1189	14014	3	3.22	0.49360	0.00050	11.755	0.014	0.17272	0.00008	2586.2	2584.2	1.5	-0.09
DRA00-K4267a Migmatized pelite, Back Lake (Z6702: 63.7446° N 109.3777°E)																	
M1	1,150,M,pY,Clr,Eu,Abr,M-0.5A	3	14900	14896	461200	3	0.01	0.49222	0.00044	11.761	0.013	0.17330	0.00007	2580.3	2589.7	1.4	0.4
M2	1,75,M,pY,Clr,Eu,Abr,M-0.5A	1	7500	7510	166700	2	0.01	0.48827	0.00044	11.650	0.013	0.17301	0.00007	2563.6	2587.0	1.4	1.1
M3	1,100,M,pY,Clr,Eu,Abr,M-0.5A	5	9006	4509	351300	4	0.01	0.48924	0.00056	11.664	0.016	0.17276	0.00007	2567.4	2584.6	1.4	0.8
DRA01-K2059 Walmsley Lake migmatite (Z7076; 63.3380°N 108.4968°E)																	
M1	1,100,M,pY,Clr,Eu,NAbr,M-0.5A	2	7903	7317	159235	3	1.01	0.49190	0.00046	11.725	0.014	0.17288	0.00007	2578.9	2585.7	1.4	0.32
M2	1,100,M,pY,Clr,Eu,NAbr,M-0.5A	2	13623	11005	254619	3	0.74	0.49094	0.00072	11.678	0.019	0.17251	0.00007	2574.7	2582.2	1.4	0.35
M3	1,100,M,pY,Clr,Eu,NAbr,M-0.5A	1	29344	23235	156645	6	0.7	0.49124	0.00046	11.685	0.014	0.17252	0.00007	2576.0	2582.2	1.4	0.29
M4	1,100,M,pY,Clr,Eu,NAbr,M-0.5A	3	16039	13333	184360	8	0.79	0.49078	0.00062	11.670	0.017	0.17246	0.00007	2574.0	2581.7	1.4	0.36
5105 Biotite Monzogranite (Z7648; 63.8964°N 109.5824°E)																	
M1	M,pY,Clr,Eu,NAbr,M-0.5A	1	13889	25311	50467.2	7	3.09	0.49358	0.00049	11.730	0.014	0.17237	0.00007	2586.2	2580.8	1.4	-0.25
M2	M,Co,Clr,Eu,NAbr,M-0.5A	1	7240	12606	45114.4	5	2.92	0.49231	0.00048	11.710	0.014	0.17251	0.00007	2580.7	2582.1	1.4	0.07
M3	M,pY,Clr,Eu,NAbr,M-0.5A	1	20532	37792	126620	5	3.15	0.49243	0.00046	11.691	0.014	0.17219	0.00007	2581.2	2579.0	1.4	-0.1
Z4	Z,Co,Clr,Eu,Pr,Abr,M0°	1	94	46	751.4	5	0.21	0.41080	0.00123	9.896	0.031	0.17471	0.00022	2218.6	2603.3	4.3	17.44
Z5	Z,Co,Clr,nFr,Eu,Pr,Abr,NM1°	1	163	98	1853.3	4	0.27	0.48261	0.00094	11.523	0.024	0.17317	0.00012	2538.6	2588.5	2.3	2.33
Z6	Z,Co,Clr,fFr,Eu,Pr,Abr,NM3°	2	106	60	1313	4	0.21	0.47994	0.00104	11.333	0.027	0.17126	0.00016	2527.0	2570.0	3.1	2.02
Z7	Z,Co,Clr,fFr,Eu,Pr,Abr,Dia	2	187	98	2033.8	4	0.22	0.44160	0.00082	10.004	0.020	0.16431	0.00015	2357.8	2500.5	3.1	6.81

[1] Fractions are number sequentially through the entire manuscript and the letter indicates the mineral type: Z=zircon; T=titanite; M=monazite.

[2] errors on atomic ratios are 1 std. error of mean , [3] error on ^{207}Pb/^{206}Pb age is 2 std error in Ma; * = Radiogenic Pb

a = include sample weight error of 0.001 mg in concentration uncertainty; c = Common Pb in analysis

** Fraction description abreviations: first figure is the number of grains, secomd is the grain size, Mineral type: Z, zircon; M, Monazite; T, titanite; Colour: pBr, pale brown; Co, colourless; pY, pale yellow; Y, yellow, br, brown; Clarity: Clr, clear, Alt, altered; Tb, turbid; Fractures: fFr, few; nFr, numerou; rFr, rare; Inclusions: fIn, few, fdIn, fluid; nIn, numerous; oIn, opaque; rIn, rare; Morphology: An, Anhedral; Eu, euhedral; El, elongate; Fg, fragment; Pr, prismatic; St, stubby prism; Sub, subhedral; Tab, tabular, Ndl, needles; Abrasion: Abr, abraded; NAbr, not abraded; Magnetic properties: M-0.5A, magnetic at 0.5 Amps; M-0.75A, magnetic at 0.75 Amps; Dia, diamagnetic, NM0°, non magnetic at 0° side slope, NM1°, non magnetic at 1° side slope; M3°, magnetic at 3° side slope

Table 2. Summary of U-Pb age interpretations

Sample	Lab#	Unit	Method	Min.	Age (Ma)	Int.	LI (Ma)	Treatment	MSWD	Fractions
DRA00-K6461	z6538	Aylmer Lake volcanic belt	ID-TIMS	Z	2676 +7/-3	IC	746 +708/-695	LR	1.83	Z1-6
DRA01-K08	z7271	Cook Lake volcanic belt	SHRIMP	Z	2673 ± 8	IC	-	WM7/6	0.87	n=10
DRA00-K4396	z6536	Margaret Lake diorite	ID-TIMS	Z	2614 +/-2	IC	forced zero	LR	0.73	z1-z3
DRA00-K4395	z6527	Zyena Lake pluton	ID-TIMS	Z & M	2603 ±2	IC	691 ± 215	LR	2.43	M1,M2,Z4
DRA00-K4339	z6652	Reid Lake pluton	SHRIMP	Z	2615 ± 8	IC	-	TB	0.05	n=11
"	"	"	ID-TIMS	M	2615 +3.5/-2.2	IC	1464± 210	LR	0.97	M2-5
DRA00-K2225	z6476	Marlo Lake pluton	ID-TIMS	M	2588 ± 1.6	IC	-	WM7/6	3.4	M1-5
DRA00-K4394	z6528	Gt-bt psammite, Back Lake	ID-TIMS	M	2585 ± 3.5	MC	-	WM7/6	3.4	M1-3
DRA01-K2059	z7076	migmatite, Walmsley Lake	ID-TIMS	M	2582 ± 1	MC	-	WM7/6	0.17	M1-3
DRA01-k4267	Zz6702	migmatized pelite, Back Lake	ID-TIMS	M	~ 2585	MC		-	-	-
DRA01-K14	z7250	Two-mica granodiorite, Cook Lake	ID-TIMS	M	2602 ± 2.5	IC		WM7/6	2.1	M1-3
5105	z7648	Monzogranite	ID-TIMS	M	2581 ± 4	IC		WM7/6	4.9	M1-3

Abbreviations: Lab# = Geological Survey of Canada Geochronology lab number; Method- ID-TIMS = Isotope dilution thermal ionisation mass spectrometry, SHRIMP = Sensitive high resolution ion microprobe; Mineral - Z = zircon; M = monazite; Int.= interpetation of age data; IC = igneous crystallization; MC = metamorphic crystallization. Treatment: LR =linear regression (modified York (1969); WM7/6 = weighted mean of ^{207}Pb/^{206}Pb ages; TB = Tukey's Biweight (Ludwig, 2000); Fractions = analyses used used in calculation (Table 1); MSWD = mean square of the weighted deviates; .

Table 3. U-Pb analytical data, SHRIMP

Spot name	Spot Location	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	^{204}Pb (ppb)	^{204}Pb/^{206}Pb	± ^{204}Pb/^{206}Pb	f(206)^{204}	^{208*}Pb/^{206*}Pb	± ^{208}Pb/^{206}Pb	^{207*}Pb/^{235}U	± ^{207}Pb/^{235}U	^{206*}Pb/^{238}U	± ^{206}Pb/^{238}U	Corr Coeff	^{207*}Pb/^{206*}Pb	± ^{207}Pb/^{206}Pb	^{206}Pb/^{238}U	± ^{206}Pb/^{238}U	^{207}Pb/^{206}Pb	± ^{207}Pb/^{206}Pb	Disc. (%)
Intermediate metavolcanic, Cook Lake Volcanic Belt (DRA01-K08)																							
7251-68.1	center	73.8	29.6	0.414	41	2	0.00006	0.00005	0.0010	0.1127	0.0020	12.63	0.19	0.49965	0.00634	0.9028	0.18329	0.00119	2612	27	2683	11	2.6
7251-69.1	center	61.6	40.7	0.682	36	1	0.00003	0.00004	0.0005	0.1885	0.0021	12.36	0.22	0.49093	0.00757	0.9185	0.18255	0.00129	2575	33	2676	12	3.8
7251-67.1	center	69.1	5.1	0.075	36	6	0.00021	0.00004	0.0036	0.0172	0.0016	12.13	0.18	0.50976	0.0064	0.8850	0.17259	0.00123	2656	27	~~2583~~	~~12~~	-2.8
7251-64.1	center	51.1	33.1	0.669	31	2	0.00008	0.00006	0.0014	0.1826	0.0028	12.87	0.20	0.51559	0.00583	0.8132	0.18100	0.00162	2680	25	2662	15	-0.7
7251-63.1	center	38.2	15.9	0.429	22	1	0.00008	0.00006	0.0014	0.1186	0.0032	12.76	0.25	0.50531	0.00639	0.7329	0.18314	0.00246	2637	27	2682	22	1.7
7251-60.1	center	14.2	5.2	0.378	8	2	0.00029	0.00015	0.0051	0.0984	0.0060	12.13	0.35	0.48862	0.00956	0.7640	0.18011	0.00336	2565	42	2654	31	3.4
7251-38.1	center	46.6	29.6	0.656	28	0	0.00001	0.00001	0.0002	0.1845	0.0086	12.98	0.20	0.51452	0.00676	0.8992	0.18301	0.00126	2676	29	2680	11	0.2
7251-26.1	center	87.5	81.2	0.959	54	2	0.00004	0.00002	0.0007	0.2661	0.0021	12.57	0.20	0.49791	0.00663	0.8836	0.18311	0.00139	2605	29	2681	13	2.9
7251-21.1	center	20.2	9.5	0.488	11	2	0.00023	0.00010	0.0039	0.1325	0.0079	12.44	0.78	0.50046	0.0218	0.7749	0.18032	0.00720	2616	94	2656	68	1.5
7251-57.1	center	74.9	47.5	0.655	45	1	0.00002	0.00004	0.0003	0.1818	0.0025	12.65	0.18	0.5095	0.00568	0.8458	0.18010	0.00139	2655	24	2654	13	0.0
7251-11.1	center	77.7	34.3	0.456	43	2	0.00005	0.00004	0.0008	0.1262	0.0020	12.32	0.19	0.48794	0.00686	0.9363	0.18309	0.00102	2562	30	2681	9	4.5
7251-13.1	center	52.0	36.7	0.729	32	2	0.00009	0.00006	0.0015	0.1999	0.0031	12.91	0.18	0.51926	0.00576	0.8583	0.18031	0.00130	2696	24	2656	12	-1.5
Reid Lake pluton (DRA00-K4339)																							
6652-7.1	rim	453.8	107.5	0.245	248	1	0.00001	0.00002	0.0001	0.1459	0.0052	12.29	0.18	0.51082	0.00624	0.8925	0.17446	0.00116	2660	27	2601	11	-2.3
6652-8.1	rim	564.5	182.7	0.334	311	11	0.00005	0.00002	0.0008	0.1395	0.0038	12.13	0.16	0.50483	0.00561	0.9109	0.17429	0.00094	2635	24	2599	9	-1.4
6652-12.1	core	100.8	111.1	1.139	62	9	0.00022	0.00010	0.0038	0.1320	0.0045	11.52	0.20	0.47566	0.00627	0.8201	0.17563	0.00178	2508	27	2612	17	4.0
6652-14.1	rim	531.5	63.0	0.123	283	28	0.00012	0.00001	0.0021	0.1961	0.0054	12.36	0.18	0.5064	0.00715	0.9619	0.17703	0.00050	2641	31	2625	5	-0.6
6652-21.1*	core	46.7	29.0	0.640	26	1	0.00006	0.00005	0.0011	0.1286	0.0042	11.42	0.19	0.48354	0.00641	0.8614	0.17134	0.00146	2543	28	2571	14	1.1
6652-32.1*	rim (altered)	1343.3	205.2	0.158	767	14	0.00002	0.00001	0.0004	0.1351	0.0041	13.43	0.15	0.54541	0.00578	0.9623	0.17862	0.00056	2806	24	~~2640~~	~~6~~	-6.3
6652-34.1	core	76.3	39.1	0.529	43	1	0.00004	0.00002	0.0007	0.1317	0.0037	11.92	0.16	0.49116	0.00565	0.8958	0.17599	0.00108	2576	24	2615	10	1.5
6652-35.1	rim	693.9	83.3	0.124	365	8	0.00003	0.00001	0.0005	0.1375	0.0045	12.27	0.16	0.50472	0.00586	0.9159	0.17628	0.00096	2634	25	2618	9	-0.6
6652-37.1	core	134.1	142.6	1.098	85	9	0.00016	0.00003	0.0027	0.1387	0.0035	12.03	0.17	0.49682	0.00563	0.8798	0.17562	0.00116	2600	24	2612	11	0.5
6652-38.1*	rim (altered)	2458.3	28.1	0.012	1477	42	0.00003	0.00001	0.0006	0.2903	0.0150	14.91	0.22	0.58696	0.00814	0.9711	0.18426	0.00065	2977	33	~~2692~~	~~6~~	-10.6
6652-40.1	rim?mix?	223.4	96.9	0.448	124	19	0.00020	0.00002	0.0035	0.1432	0.0039	11.95	0.17	0.49226	0.00611	0.9279	0.17610	0.00093	2580	26	2616	9	1.4
6652-51.1	core	131.5	146.1	1.147	82	4	0.00008	0.00002	0.0014	0.1336	0.0033	11.69	0.17	0.48511	0.0054	0.8532	0.17470	0.00130	2549	24	2603	12	2.1
6652-59.1	rim	751.6	159.1	0.219	399	3	0.00001	0.00000	0.0001	0.1362	0.0036	12.22	0.15	0.4989	0.00554	0.9630	0.17765	0.00058	2609	24	2631	5	0.8
6652-66.1	rim	805.0	66.2	0.085	429	12	0.00003	0.00001	0.0006	0.1348	0.0048	12.66	0.16	0.51688	0.00582	0.9429	0.17769	0.00075	2686	25	2631	7	-2.1
6652-72.1*	core	46.2	37.5	0.838	28	1	0.00007	0.00005	0.0013	0.1401	0.0040	12.84	0.19	0.49934	0.00614	0.8726	0.18654	0.00139	2611	26	~~2712~~	~~12~~	3.7

Notes (see Stern, 1997; Stern and Amelin, 2003 for analytical details):

* = analsyes excluded frm age calculation in text. Uncertainties reported at 1σ (absolute) and are calculated by numerical propagation of all known sources of error

Calibration standard : BR266 - Age 559.0 Ma; ^{206}Pb/^{238}U = 0.09059; error 1.0%

f206^{204} refers to mole fraction of total ^{206}Pb that is due to common Pb, calculated using the ^{204}Pb-method; common Pb composition used is the surface blank: 4/6: 0.05770; 7/6: 0.89500; 8/6: 2.1

Discordance relative to origin = 100 * (1-(^{206}Pb/^{238}U age)/(^{207}Pb/^{206}Pb age))

Table 4. Mineral assemblages by sample. All samples contain quartz, plagioclase, garnet, biotite. Symbol (X) denotes presence of a mineral in the sample, rounded brackets denote <1 modal percent of mineral present in sample, angular brackets indicate the mineral is altered and/or retrograded. Mineral abbreviations after Kretz 1983.

Sample	als	crd	ms	Kfs	st
0287	and	X	X		
0174	(and)				
0293	(and)				
0383	(and)				
4085	(sil)				X
0396	(sil)				
0220	(sil)				
0613	(sil)	X			
1026	(sil)	<X>			
0032b	(sil)				
2326b	(sil)	X			
1074	(sil)	<X>			
2133	(sil)	X		X	

Table 5. Selected* electron microprobe analyses from the Walmsley Lake Area, analyses used for thermobarometric calculations.

Garnet analyses weight percent oxide

	1074	0032b	1026	2133	4085	2326b	287	293	383	396	613	174	220
SiO_2	36.75	37.01	37.11	37.08	36.88	36.92	36.78	36.79	37.29	37.06	37.08	36.89	37.22
K_2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO	33.99	31.83	33.41	32.15	32.54	33.62	26.93	32.63	31.23	28.33	32.28	30.24	32.55
MgO	3.96	3.48	3.12	6.02	3.16	3.81	2.51	2.55	3.95	3.28	3.57	2.83	3.67
Al_2O_3	20.28	21.08	21.26	21.28	21.05	21.17	21.08	21.24	21.67	21.54	21.46	21.11	21.43
CaO	0.97	1.31	0.90	1.72	1.24	0.69	1.59	1.72	1.71	2.40	1.19	2.44	0.89
MnO	2.56	4.98	4.43	1.13	4.75	3.40	10.73	4.64	4.08	6.65	4.20	6.18	4.45
TiO_2	0.00	0.04	0.00	0.00	0.00	0.00	0.08	0.02	0.01	0.00	0.02	0.00	0.00
Total	98.52	99.74	100.23	99.39	99.62	99.61	99.70	99.56	99.94	99.26	99.80	99.69	100.20

Biotite analyses weight percent oxide (average)

	1074	0032b	1026	2133	4085	2326b	287	293	383	396	613	174	220
Na_2O	0.27	0.28	0.27	0.29	0.40	0.18	0.01	0.15	0.39	0.23	0.28	0.16	0.24
SiO_2	35.86	35.79	34.95	36.61	35.56	33.26	24.40	35.71	37.10	37.05	36.09	35.80	36.04
K_2O	8.85	9.24	9.20	8.48	9.27	5.36	0.03	9.12	7.88	8.68	9.02	9.00	8.59
FeO	17.54	17.28	18.80	15.47	18.05	19.90	22.71	19.22	16.70	17.20	18.33	18.75	18.47
MgO	11.14	10.49	9.57	13.20	10.12	12.24	16.30	10.41	13.48	12.16	11.50	11.08	11.18
Al_2O_3	18.19	18.94	18.79	16.96	19.00	19.49	23.72	19.08	18.08	18.37	19.32	18.80	19.09
CaO	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.03	0.07	0.08	0.03	0.04	0.06
MnO	0.06	0.11	0.09	0.04	0.09	0.15	0.41	0.07	0.06	0.13	0.08	0.13	0.10
TiO_2	1.73	1.81	2.02	1.90	1.64	1.37	0.07	1.55	1.29	1.95	1.55	1.82	1.76
Cr_2O_3	0.00	0.00	0.00	0.00	0.00	0.11	0.07	0.07	0.10	0.13	0.13	0.06	0.10
F	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.20	0.22	0.17	0.18	0.17	0.13
Cl	0.01	0.01	0.01	0.01	0.02	0.02	0.00	0.01	0.01	0.02	0.01	0.01	0.00
Total	93.65	93.95	93.69	92.95	94.14	92.20	87.73	95.55	95.29	96.09	96.43	95.74	95.69

Plagioclase analyses weight percent oxide (average)

	1074	0032b	1026	2133	4085	2326b	287	293	383	396	613	174	220
Na_2O	8.63	8.36	8.73	7.12	8.64	9.73	7.29	7.56	8.34	6.60	8.40	7.70	9.40
SiO_2	61.65	60.86	61.72	58.01	61.42	63.82	57.28	59.37	61.06	57.58	61.20	59.76	62.99
K_2O	0.08	0.07	0.06	0.06	0.08	0.08	0.18	0.07	0.05	0.27	0.07	0.07	0.11
FeO	0.05	0.10	0.10	0.00	0.07	0.04	0.31	0.15	0.11	0.11	0.05	0.14	0.16
MgO	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0	0.00	0.01
Al_2O_3	23.73	24.30	23.84	26.25	23.91	23.11	26.26	26.22	25.33	27.27	24.80	26.22	23.25
CaO	4.76	5.43	4.72	7.52	4.93	3.68	7.60	7.48	6.29	8.55	5.78	7.53	4.10
Total	98.90	99.12	99.17	98.97	99.05	100.47	98.94	100.85	101.18	100.41	100.31	101.42	100.03

Analyses were carried out using a JEOL 8900 electron microprobe at the University of Alberta. Analyses were performed using an accelerating voltage of 15kV and a beam current of 15nA. Data were reduced using ZAF correction procedures. Beam diameter was maintained at 3μm (minimum) for garnet and plagioclase, and 5μm for biotite, quantitative spot analyses. Natural minerals were used as standards. Garnet: Al, Ca, Mg, Si, Roberts Victor garnet; Fe, Rockport fayalite; Mn, willemite. Ti kaersuitite. Plagioclase: Al, Ca, Lake Country plagioclase; Si, K, sanadine, Na, albite; Biotite: Fe, Mg, K, Si, F Calgary biotite; Ti, Ca, Na, kaersuitite; Cl tugtupite; Cr chromite; Mn willemite; Al muscovite.

*The complete dataset is available through the CS Lord Northern Geoscience Centre, Box 1500, Yellowknife, NT, X1A 2L3 cslord_centre@gov.nt.ca

Table 6. Selected electron microprobe analyses for cordierite and staurolite from the Walmsley Lake area.

Sample	4085	287	2133
Mineral	staurolite	cordierite	cordierite
NA_2O	0.00	0.30	0.30
SiO_2	26.93	47.44	48.30
K_2O	0.00	0.03	0.02
FeO	12.88	7.65	6.19
MgO	1.69	7.96	9.32
Al_2O_3	54.16	33.28	32.96
CaO	0.01	0.02	0.01
MnO	0.28	0.73	0.07
TiO_2	0.68	0.01	N/A
ZnO	0.53	N/A	N/A
Total	97.15	97.42	97.19

Analyses were carried out using a JEOL 8900 electron microprobe at the University of Alberta. Analyses were performed using an accelerating voltage of 15kV and a beam current of 15nA. Data were reduced using ZAF correction procedures. Beam diameter was maintained at 5 μm. Natural Minerals were used as standards. Staurolite, Al, Ca, Mg, Si Roberts-Victor garnet, K, Na, Kakanui anorthoclase, Fe, Ti Kakanui hornblende, Mn willemite, Zn gahnite. Muscovite: Al, K, Si, Nain osumilite; Fe, Mg Roberts-Victor garnet, Ti, Ca, Na kaersuitite; Mn willemite. Cordierite: Na, Ca, Ti kaersuitite, Al, Great Sitkin Island anorthite, Si, K Nain osumilite; Mn willemite, Fe, Mg, Roberts-Victor garnet. N/A = not analysed.

Table 7. P-T estimates obtained from TWQ 2.02b Berman (1997) using GARB thermometry and, GASP and cordierite equilibria (CORD) barometry. See text for equilibria and models.

	TWQ 2.02b			
	GARB	GASP	CORD	
Sample	T (°C)	P (Kbar)	T (°C)	P (Kbar)
Cordierite Zone				
0287	500	2.1	580	3.6
0293	580	4.0	-	-
Upper Cordierite Zone				
0383	600	5.2	-	-
0174	610	6.3	-	-
0396	620	6.0	-	-
0613	620	4.7	-	-
Sillimanite Zone				
0220	625	5.5	-	-
2326b	630	5.0	-	-
1074	640	5.1	-	-
0032b	600	4.3	-	-
1026	620	4.2	-	-
4085	620	5.4	-	-
Migmatite Zone				
2133	710	7.0	700	6.0

References

Armstrong, J.P. and Kenny, G. 2001. Slave Magnetics Compilation (SMAC). A digital image compilation of publically available total field magnetics data as filed under the Canada Mining Regulations: Northwest Territories and Nunavut, Canada. DIAND NWT Geology Division, EGS Open Report 2001-003.

Beaumont, C., Jamieson, R.A., Nugyen, M.H., and Lee, B., 2001. Himalayan tectonics explained by extrusion of a low-viscosity crustal channel coupled to focused surface denudation. Nature, **414**: 738-742.

Berman, R.G., 1997. TWQ (Thermobarometry with estimation of equilibrium state, Version 2.02b), Geological Survey of Canada, Ottawa.

Berman, R.G., and Aranovich, R.D., 1996a: Optimized standard state and mixing properties of minerals; I, Model calibration for olivine, orthopyroxene, cordierite, garnet, ilmenite in the system FeO, MgO, CaO, Al_2O_3, TiO_2, SiO_2. Contributions to Mineralogy and Petrology, **126**: 1-24.

Berman, R.G., and Aranovich, R.D., 1996b: Optimized standard state and mineral properties; II, Comparisons, predictions and applications. Contributions to Mineralogy and Petrology, **126**: 25-47.

Bethune, K.M. and Carmichael, D.M., 1998. Metamorphism along the Slave portion of the SNORCLE Transect. *In* Lithoprobe, Slave – Northern Cordillera Lithospheric Evolution (SNORCLE) and Cordilleran Tectonics Workshop, 6-8 March, Burnaby. *Compiled by* F. Cook and P. Erdmer. Lithoprobe Report 64: 17-24.

Bleeker, W., Ketchum, J.W.F, Jackson, V.A., and Villeneuve, M.E.,1999. The Central Slave Basement Complex, Part I: its structural topology and autochthonous cover. Canadian Journal of Earth Sciences, **36**: 1083-1109.

Cairns, S.R., 2003. Highlights of the 2002 bedrock mapping component of the Walmsley Lake Targeted Geoscience Initiative, southeastern Slave Province, Northwest Territories. Geological Survey of Canada, Current Research, C-09: 9p.

Cairns, S.R., MacLachlan, K., Relf, C., and Davis, W.J., 2003: A digital atlas of the Walmsley Lake area. CS Lord Northern Geoscience Centre, EGS 2003-04.

Clemens, J.D., and Vielzeuf, D., 1987. Constraints of melting and magma production in the crust. Earth and Planetary Science Letters, **86**: 287-306.

Davidson, A., 1972. Granite studies in the Slave Province; Report of Activities, Part A. Geological Survey of Canada, Paper 1971-1a: 109-115.

Davis, W. and Bleeker, W., 1999. Timing of plutonism, deformation and metamorphism in the Yellowknife Domain, southern Slave Province. Canadian Journal of Earth Science, **36**: 1169-1187.

Davis, W.J., McNicoll, V., Bellerive, D., Scott, D.J., 1997. Modified chemical procedures for the extraction and purification of uranium from titanite, allanite and rutile in the Geochronology Laboratory, Geological Survey of Canada. *In* Current Research, Geological Survey of Canada Paper 1997-F, 33-36.

Davis, W.J., Fryer, B.J., and King, J.E., 1994. Geochemistry and evolution of Late Archean plutonism and its significance to the tectonic development of the Slave Craton. Precambrian Research, **67**: 207-241.

Davis, W.J., and Hengner, E., 1992. Neodymium isotopic evidence for tectonic assembly of late Archean crust in the Slave Province, Northwest Canada. Contributions to Mineralogy and Petrology, **111**: 307-313.

de Wit, M. J., 1998. On Archean granites, greenstones, cratons and tectonics: does the evidence demand a verdict? Precambrian Research, **91**: 181-226.

Essene, E. J., 1989. The current status of thermobarometry in metamorphic rocks. *In* Daly, J.S., Cliff, R.A., and Yardley, B.W.D., (eds), Evolution of Metamorphic Belts, Geological Society Special Publication No.43: 245-263.

Frith, R. A., van Breeman, O., and Mortensen, J. K., 1991. U-Pb dating from tonalite and felsic volcanic rocks in the Brislane Lake area of the southern Slave Province. *In* Radiogenic age and isotopic studies: report 4. Geological Survey of Canada, Paper 90-2: 85-90.

Fuhrman, M.L., and Lindsley, D.H., 1988. Ternary-feldspar modeling and thermometry. The American Mineralogist, **73**: 201-216.

Fyson, W. K., 1996. CorelDraw! Diagrams of the geology of the Slave Structural Province. EGS Open File 1996-08, NWT Geology Division, Department of Indian Affairs and Northern Development, Yellowknife, NWT. 3 figures.

Fyson, W.K., and Jackson, V., 2003. Structures in supracrustal and plutonic rocks, Snare River, Archean Slave Province. NWT geology division, Department of Indian Affairs open file report, in press.

Fyson, W.K., and Helmsteadt, H., 1988. Structural patterns and tectonic evolution of supracrustal domains in the Archean Slave Province, Canada, Canadian Journal of Earth Sciences, **25**: 301-315.

Gerdes, A., Wörner, G., and Henk, A., 2000. Post-collisional granite generation and HT-LP metamorphism by radiogenic heating: the Varsican south Bohemian Batholith. Journal of the Geological Society, London, **157**: 577-587.

Green, D.C., and Baadsgaard, H., 1971. Temporal evolution and petrogenesis of an Archean crustal segment at Yellowknife, N.W.T., Canada. Journal of Petrology, **12**: 177-217.

Hamilton, W.B., 1998. Archean magmatism and deformation were not the products of plate tectonics. Precambrian Research, **91**: 143-180.

Harte, B., and Hudson, N.F.C., 1979. Pelite facies series and the temperatures and pressures of Daldrinian metamorphism in E. Scotland. *In* A.L. Harris, C.H. Holland, and B.E. Leake (eds) Geological Society of London Special Publication No. 8, 323-337.

Hauck, M.L., Nelson, K.D., Brown, L.D., Zhao, W., and Ross, A.R., 1998. Crustal structure of the Himalyan orogen at ca. 90° east longitude from project INDEPTH deep reflection profiles. Tectonics, **17**: 481-500.

Henderson, J B., 1989. Geology, Artillery Lake Area, Northwest Territories; Geological Survey of Canada, Open File 2010, 1 sheet.

Henderson, J.B., 1985. Geology of the Yellowknife-Hearne Lake area, District of MacKenzie: a segment across an Archean basin. Geological Survey of Canada, Memoir 414, 135p, 1:250 000 map.

Henderson, J.B., 1981. Archean basin evolution in the Slave Province, Canada. *In* Developments in Precambrian geology 4. *Edited by* A. Kröner, Elsvier, Amesterdam, pp. 213-235.

Henderson, J. B. and van Breemen, O., 1992. U-Pb zircon ages from Archean orthogneisses and Proterozoic metasedimentary gneisses of the Thelon Tectonic Zone, District of Mackenzie, N.W.T. *In* Radiogenic and Isotope Studies: Report 6, Geological Survey of Canada, Paper 91-2: 25-33.

Henderson, J.B., James, D.T., Thompson, P.H., 1999. Geology, Healey Lake-Artillery Lake, Northwest Territories-Nunavut; Geological Survey of Canada, Open File 3819, 1 sheet.

Henderson, J. B., van Breemen, O., and Loveridge, W. D., 1987. Some U-Pb zircon ages from Archean basement, supracrustal and intrusive rocks, Yellowknife-Hearne Lake area, District of Mackenzie. *In* Radiogenic and Isotope Studies: Report 1, Geological Survey of Canada, Paper 87-2: 111-121.

Hodges, K.V., 2000. Tectonics of the Himalayan and southern Tibet from two perspectives. Bulletin of the Geological Society of America, V. **112**: 324-350.

Hoffman, P.F., 1990. On accretion of granite-greenstone terranes. *In* Proceedings, NUNA Conference Volume on Greenstone Gold and Crustal Evolution. *Edited by* F. Robert, P.A. Sheahan, and S.B. Green. Geological Association of Canada, pp. 32-45.

Isachsen, C.E., Bowering, S.A., and Padgham, W.A., 1991. U-Pb zircon geochronology of the Yellowknife volcanic belt and subjacent rocks, NWT Canada: new constraints on the timing and duration of greenstone belt magmatism. Journal of Geology, **99**: 55-67.

Jackson, V.A., 1989. Metamorphic and structural evolution of Archean rocks in the Keskarrah Bay area, Point Lake, District of Mackenzie, N.W.T. Unpublished M.Sc thesis, Memorial University of Newfoundland. 313 p.

King, J. E., and Helmstaedt, H., 1997. The Slave Province, Northwest Territories, Canada. In Greenstone belts. Edited by M. de Wit and L.D. Ashwal. Oxford Monograph on Geology and Geophysics 35: 459-479.

Kohn, M.J., and Spear, F., 2000. Retrograde net transfer reaction insurance for pressure-temperature estimates. Geology, **28**: 1127-1130.

Kretz, , R., 1983. Symbols for rock forming minerals. American Mineralogist, **68**: 277-279.

Krogh, T.E., 1982. Improved accuracy of U/Pb ages by the creation of more concordant systems using an air abrasion technique. Geochimica et Cosmochimica Acta 46: 637-649.

Kusky, T.M., 1989. Accretion of the Archean Slave Province. Geology, **17**: 63-68.

Kusky, T.M., 1993. Collapse of Archean orogens and the generation of late to postkinematic granitoids. Geology, **21**: 925-928.

Ludwig, K.R. 2000. Isoplot/Ex ver. 2.2. A Geochronological Toolkit for Microsoft Excel, Berkeley Geochronology Center, Special Publication No. 1a.

Macfie, R.I., van Breeman, O., and Loveridge, W. D., 1990. Late Archean U-Pb zircon age for the Clinton-Colden gabbro-anorthosite intrusion, eastern Slave Province, District of Mackenzie, Northwest Territories. *In* Radiogenic age and isotopic studies: report 3. Geological Survey of Canada, Paper 89-2: 45-48.

MacLachlan, K., Relf, C., Cairns, S.R., Renaud, J., and Mills, A., 2002. New bedrock mapping and preliminary U/Pb geochronology in the Walmsley Lake area, southeastern Slave Province, NWT. Geological Survey of Canada, Current Research 2002-C1: 10p.

MacLachlan, K., Relf, C., Cairns, S.R., Hardy, F., and Davis, B., 2001a. New multidisciplinary geological investigations in the Walmsley Lake area, southeastern Slave Province, NT. Geological Survey of Canada, Current Research 2001-C4: 19p.

MacLachlan, K., Relf, C., and Cairns, S.R., 2001b. Preliminary geology of the Back Lake area, parts of NTS 75N/5, 11, 12, 13, and 14. Geological Mapping Division, Department of Indian Affairs and Northern Development EGS 1995-04: 1 map, 125K.

MacLachlan, K., and Helmstaedt, H., 1995. Geology and geochemistry of an Archean mafic dike complex in the Chan Formation: basis for a revised plate-tectonic model of the Yellowknife greenstone belt. Canadian Journal of Earth Sciences, **32**: 614-630.

McMullin, D., Berman, R., Greenwood, H., 1991. Calibration of the SGAM thermobarometer for pelitic rocks using data from phase equilibrium experiments and natural assemblages. Canadian Mineralogist, **29**: 889-908.

Nelson, K.D., 1992. Are crustal thickness variations in old mountain belts like the Appalachians a consequence of lithosperic delamination? Geology, **20**: 498-502.

Parrish, R.R., Roddick, J.C., Loveridge, W.D., Sullivan, R.W., 1987. Uranium-Pb analytical techniques at the geochronology laboratory, Geological Survey of Canada. *In* Radiogenic Age and Isotope Studies: Report 1, Geological Survey of Canada Paper 87-2, pp. 3-7

Patiño Douce, A.E., Humphreys, E.D., and Johnston, A.D., 1990. Anatexis and metamorphism in tectonically thickened continental crust exemplified by the Sevier hinterland, western North America. Earth and Planetary Science Letters, **97:** 290-315.

Pattison, D.R.M., 2001. Instability of Al_2SiO_5 triple point assemblages in muscovite + biotite + quartz bearing metapelites,with implications. American Mineralogist, **86**, 1414-1422.

Pattison, D.R.M., Spear, F., and Cheney, J.T., 1999. Polymetamorphic origin of muscovite + cordierite + staurolite + biotite assemblages: implications for the metapelitic petrogenetic grid and for P-T paths. Journal of Metamorphic Geology, **17**: 685-703.

Pattison, D.R.M. and Tracy, R.J., 1991. Phase equilibria and thermobarometry of metapelites. *In* Contact Metamorphism ed. Kerrick D.M. Mineralogical Society of America, Reviews in Mineralogy, **26**: 105-206.

Pehrsson, S.J., and Chacko, T., 1997. Contrasting styles of deformation and metamorphism between mid and upper crustal rocks of the western Slave Province, Northwest Territories. Geological Survey of Canada, Current Research 1997-C: pp. 15-25.

Ramsey, J.G., 1967. Folding and Fracturing in Rocks; McGraw-Hill Book Co., New York, New York: 568p.

Relf, C., 1992a. Two distinct shortening events during late Archean orogeny in the west-central Slave Province, Northwest Territories, Canada. Canadian Journal of Earth Sciences, **29**: 2104-2117.

Relf, C. 1992b. Structural and metamorphic history of the Contwoyto Lake area, N.W.T., Implications for the tectonic evolution of the Central Slave Province. Unpublished Ph.D. Thesis, Queens University. 375 p.

Renaud, J., 2003. The stratigraphy and economic potential of the Aylmer Lake volcanic belt, Slave Structural Province, Northwest Territories. M.Sc. Thesis, University of Western Ontario. 350p.

Renaud, J., MacLachlan, K., and Cairns, S.R., 2002. Stratigraphy and structure of the Aylmer Lake volcanic belt and surrounding metasedimentary rocks, Northwest Territories. Geological Survey of Canada, Paper 2002-C2: 11p.

Renaud, J., MacLachlan, K., Relf, C., and Duke, N., 2001. Volcanic stratigraphy and mineral potential of the Aylmer dome, southeastern Slave Province, Northwest Territories. Geological Survey of Canada, Current Research, 2001-C5: 16p.

Roddick, J.C., 1987. Generalized numerical error analysis with applications to geochronology and thermodynamics. Geochimica et Cosmochimica Acta 51: 2129-2135.

Sandiford, M., 1989. Horizontal structures in granulite terrains: A record of mountain building or mountain collapse? Geology, **17**: 449-452.

Schultz, M., 2002. Application of Th-U- total Pb chemical dating by electron microprobe to a polygenetic late Archean terrane, Walmsley Lake area, Slave Province, NWT, Canada. Unpublished B.Sc. thesis, University of Alberta: 39p.

Spear, F.S., 1995. Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths. Mineral Society of America Monograph, Washington, D.C. 799p.

Spear, F.S., and Cheney, J.T., 1989. A petrogenetic grid for pelitic schists in the system $SiO_2 - Al_2O_3 - FeO - MgO - K_2O - H_2O$. Contributions to Mineralogy and Petrology, **101**: 149-164.

Spear, F.S., Kohn, M.J. and Cheney, J.T. 1999. P-T paths from anatectic pelites. Contributions to Mineralogy and Petrology, **134**: 17-32.

Stern, R.A., 1997. The GSC sensitive high resolution ion microprobe (SHRIMP): analytical techniques of zircon U-Th-Pb age determinations and performance evaluation. *In* Radiogenic age and isotope studies: Report 10. Geological Survey of Canada, Current Research 1997-F: pp. 1-31.

Stern, R. A. and Amelin, Y. 2003. Assessment of errors in SIMS zircon U-Pb geochronology using a natural zircon standard and NIST SRM 610 glass. Chemical Geology, 197: 111-142.

Stubley, M., Jaegli, K., Bilben, S., and Tyler, T. 1995. Geology of the Nardin Lake area, south-central Slave Province, Parts of NTS 85P/5, 12; 85O/8, 9 Geological Mapping Division, Indian Affairs and Northern Development, EGS 1995-04.

Thompson, P. H. 1978. Archean regional metamorphism in the Slave Structural Province – a new perspective on some old rocks. *In* Metamorphism in the Canadian Shield. *Edited by* J.A. Fraser and W.W. Heywood. Geological Survey of Canada, Paper 78-10: 85-102.

Thompson, P.H., 1989. An empirical model for metamorphic evolution of the Archaean Slave Province and adjacent Thelon Tectonic Zone, northwestern Canadian Shield. *In* Daly, J.S., Cliff, R.A., and Yardley, B.W.D., (eds), Evolution of Metamorphic Belts, Geologic Society Special Publication No.43: 245-263.

Thorpe, R.I., Cumming, G.L., and Mortensen, J.K., 1992: A significant Pb isotope boundary in the Slave Province and it's probable relationship to ancient basement in the western Slave Province; in Project Summaries, Canada-NWT Mineral Development Agreement 1987-1991; Geological Survey of Canada, Open File 2484: 179-184.

Todd, C.S., 1998. Limits on the precision of geobarometry at low grossular and anorthite contents. American Mineralogist, **83**: 1161-1167.

van Breeman, O., Davis, W.J., and King, J.E., 1992. Temporal distribution of granitoid plutonic rocks in the Archean Slave Province, northwestern Canadian Shield. Canadian Journal of Earth Sciences, **29**: 2186-2199.

van Breeman, O. and Henderson, J. B., 1988. U-Pb zircon and monazite ages from the eastern Slave Province and Thelon Tectonic Zone, Artillery Lake area, N.W.T. *In* Radiogenic age and isotopic studies: report 2. Geological Survey of Canada, Paper 88-2: 73-83.

van Breemen, O., Henderson, J. B., Sullivan, R. W., and Thompson, P. H., 1987. U-Pb zircon and monazite ages from the eastern Slave Province, Healey Lake area, N.W.T. *In* Radiogenic age and isotopic studies: report 1. Geological Survey of Canada, Paper 87-2: 101-110.

van der Valden, A.J., and Cook, F., 2002, Products of 2.65-2.58 Ga orogenesis in the Slave Province correlated with Slave – Northern Cordillera Lithospheric Evolution (SNORCLE) seismic reflection patterns. Canadian Journal of Earth Sciences, **38**: 1189-1200.

Yamashita, K., and Creaser, R.A. 1999. Geochemical and Nd isotopic constraints for the origin of Late Archean turbidites from the Yellowknife Area, Northwest Territories, Canada. Geochimica et Cosmochica Acta, **63**: 2579-2598.

York, D., 1969. Least squares fitting of a straight line with correlated errors. Earth and Planetary Science Letters **5**: 320-324.

Zwart, H.J., 1962. On the determination of polymetamorphic mineral associations, and its application to the Bosost area (central Pyrenees). Geologish Rundschau, **52:** 38-65.

Appendix 1 Mineral Chemistry Data

Appendix 1 Mineral Chemistry

Garnet Chemistry

	Weight percent oxide								Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0396-2gt-1-1	37.12	0.013	21.578	27.778	8.523	2.437	2.275	99.724	2.9909	0.0008	2.0493	1.8719	0.5817	0.2927	0.1964	7.9837
TS0396-2gt-1-2	37.074	0.001	21.45	28.098	8.203	2.613	2.246	99.685	2.9893	0.0001	2.0387	1.8948	0.5603	0.3141	0.1941	7.9914
TS0396-2gt-1-3	36.961	0.006	21.174	28.312	7.827	2.844	2.256	99.38	2.9901	0.0004	2.0191	1.9156	0.5363	0.3429	0.1955	7.9999
TS0396-2gt-1-4	37.081	0.009	21.377	28.51	7.749	2.808	2.235	99.769	2.9872	0.0005	2.0299	1.9208	0.5288	0.3372	0.193	7.9975
TS0396-2gt-1-5	37.343	0	21.38	28.348	7.561	2.839	2.333	99.804	3.0008	0	2.0251	1.9051	0.5147	0.3401	0.2009	7.9868
TS0396-2gt-1-6	37.271	0	21.391	28.238	7.445	2.94	2.258	99.543	3	0	2.0294	1.9008	0.5076	0.3527	0.1947	7.9852
TS0396-2gt-1-7	37.088	0	21.461	28.116	7.371	2.864	2.286	99.186	2.9951	0	2.0428	1.8989	0.5042	0.3448	0.1978	7.9836
TS0396-2gt-1-8	37.225	0	21.602	28.499	7.372	3.001	2.247	99.946	2.9859	0	2.0424	1.9118	0.5009	0.3588	0.1931	7.9929
TS0396-2gt-1-9	36.903	0	21.471	28.383	7.167	3.03	2.335	99.289	2.9802	0	2.0438	1.9169	0.4902	0.3647	0.2021	7.998
TS0396-2gt-1-10	36.772	0.003	21.376	28.599	7.101	3.113	2.413	99.377	2.9715	0.0002	2.036	1.9328	0.486	0.375	0.209	8.0105
TS0396-2gt-1-1	36.985	0.002	21.566	28.598	7.152	3.131	2.281	99.715	2.9749	0.0001	2.0447	1.9238	0.4873	0.3754	0.1966	8.0028
TS0396-2gt-1-2	36.985	0	21.499	28.616	6.958	3.131	2.366	99.555	2.9784	0	2.0408	1.9273	0.4746	0.3758	0.2042	8.0012
TS0396-2gt-1-3	37.334	0	21.426	28.459	6.971	3.227	2.279	99.696	2.9966	0	2.027	1.9103	0.4739	0.3862	0.196	7.99
TS0396-2gt-1-4	36.99	0.035	21.597	28.525	6.904	3.286	2.323	99.66	2.9729	0.0021	2.0459	1.9173	0.47	0.3937	0.2001	8.002
TS0396-2gt-1-5	36.989	0.014	21.513	28.481	6.844	3.208	2.424	99.473	2.9784	0.0009	2.0418	1.9179	0.4668	0.3851	0.2091	8
TS0396-2gt-1-6	37.057	0.004	21.54	28.332	6.649	3.28	2.402	99.264	2.9846	0.0002	2.0449	1.9084	0.4536	0.3938	0.2073	7.9928
TS0396-2gt-1-7	37.186	0	21.5	28.44	6.531	3.297	2.404	99.458	2.9893	0	2.0372	1.912	0.4515	0.395	0.2071	7.9921
TS0396-2gt-1-8	37.21	0.042	21.567	28.321	6.791	3.257	2.415	99.603	2.9868	0.0025	2.0406	1.9013	0.4618	0.3897	0.2077	7.9904
TS0396-2gt-1-9	37.238	0.038	21.674	28.636	6.766	3.242	2.453	100.047	2.9791	0.0023	2.0438	1.916	0.4585	0.3866	0.2103	7.9966
TS0396-2gt-1-10	37.103	0.018	21.589	28.344	6.692	3.175	2.436	99.357	2.9858	0.0011	2.0478	1.9076	0.4562	0.3808	0.2101	7.9895
TS0396-2gt-1-11	37.126	0.001	21.578	28.515	6.843	3.157	2.505	99.725	2.9812	0.0001	2.0424	1.915	0.4654	0.378	0.2155	7.9977
TS0396-2gt-1-12	37.072	0.021	21.486	28.697	6.664	3.067	2.541	99.548	2.9836	0.0012	2.0382	1.9316	0.4543	0.368	0.2191	7.9961
TS0396-2gt-1-13	37.075	0.026	21.576	28.599	6.749	3.163	2.529	99.717	2.978	0.0016	2.0428	1.9212	0.4592	0.3787	0.2177	7.9992
TS0396-2gt-1-14	37.1	0.052	21.65	28.436	6.633	3.233	2.415	99.519	2.9807	0.0031	2.0502	1.9107	0.4514	0.3871	0.2079	7.9911
TS0396-gt1-2-1	37.247	0	21.482	27.697	8.368	2.408	2.502	99.704	2.9998	0	2.0393	1.8656	0.5709	0.289	0.2159	7.9805
TS0396-gt1-2-2	37.088	0	21.509	27.712	8.017	2.507	2.548	99.381	2.9942	0	2.0468	1.8711	0.5483	0.3017	0.2205	7.9826
TS0396-gt1-2-3	37.315	0.035	21.352	27.955	7.94	2.645	2.443	99.685	3.0032	0.0021	2.0255	1.8817	0.5413	0.3173	0.2107	7.9819
TS0396-gt1-2-4	37.112	0.038	21.376	27.733	7.878	2.667	2.472	99.276	2.9976	0.0023	2.0351	1.8734	0.539	0.3211	0.214	7.9826
TS0396-gt1-2-5	37.226	0	21.451	27.912	7.919	2.678	2.416	99.602	2.9979	0	2.0361	1.8799	0.5402	0.3215	0.2084	7.9841
TS0396-gt1-2-6	37.299	0	21.617	28.174	7.863	2.744	2.439	100.136	2.989	0	2.0419	1.8882	0.5337	0.3278	0.2094	7.99
TS0396-gt1-2-7	37.251	0	21.609	28.304	7.607	2.825	2.354	99.95	2.9889	0	2.0437	1.8993	0.517	0.3379	0.2024	7.9893
TS0396-gt1-2-8	36.944	0	21.425	28.333	7.504	2.89	2.412	99.508	2.9811	0	2.0378	1.912	0.5129	0.3477	0.2085	8
TS0396-gt1-2-9	37.308	0.005	21.558	28.296	7.409	2.928	2.468	99.972	2.9909	0.0003	2.037	1.8971	0.5031	0.3499	0.212	7.9903
TS0396-gt1-2-10	37.028	0	21.666	28.371	7.407	2.983	2.49	99.945	2.9726	0	2.0501	1.9048	0.5037	0.357	0.2142	8.0024
TS0396-2gt-2-1	36.833	0	21.707	28.147	7.202	3.036	2.491	99.416	2.9688	0	2.0622	1.8974	0.4917	0.3648	0.2151	8
TS0396-2gt-2-2	37.046	0	21.572	28.245	7.095	3.021	2.436	99.415	2.984	0	2.0481	1.9027	0.4841	0.3628	0.2103	7.992
TS0396-2gt-2-3	36.954	0.009	21.795	28.433	7.28	3.104	2.386	99.961	2.9645	0.0005	2.0608	1.9076	0.4947	0.3712	0.2051	8.0044
TS0396-2gt-2-4	36.94	0	21.463	28.277	7.204	3.07	2.152	99.106	2.9859	0	2.0448	1.9115	0.4932	0.3699	0.1864	7.9917
TS0396-2gt-2-5	37.184	0	21.582	28.59	7.234	3.177	2.173	99.94	2.9821	0	2.0401	1.9176	0.4914	0.3798	0.1867	7.9978
TS0396-2gt-2-6	37.314	0	21.669	28.528	6.967	3.201	2.268	99.947	2.9871	0	2.0446	1.91	0.4724	0.3819	0.1946	7.9907
TS0396-2gt-2-7	37.101	0	21.358	28.431	6.977	3.275	2.235	99.377	2.9894	0	2.0285	1.9159	0.4762	0.3934	0.193	7.9964
TS0396-2gt-2-8	37.231	0	21.613	28.59	6.89	3.238	2.376	99.938	2.9826	0	2.0408	1.9155	0.4676	0.3866	0.2039	7.9971
TS0396-2gt-2-9	37.261	0.03	21.432	28.411	6.886	3.339	2.366	99.725	2.9895	0.0018	2.0268	1.9064	0.468	0.3994	0.2034	7.9953
TS0396-2gt-2-10	37.083	0	21.312	28.548	6.743	3.239	2.395	99.32	2.99	0	2.0255	1.9251	0.4605	0.3893	0.2069	7.9973
TS0396-2gt-2-11	37.181	0.001	21.419	28.491	6.694	3.207	2.334	99.327	2.9942	0.0001	2.0331	1.9189	0.4566	0.385	0.2014	7.9894
TS0396-2gt-2-12	37.005	0	21.642	28.392	6.734	3.18	2.346	99.299	2.9807	0	2.0548	1.9127	0.4594	0.3818	0.2025	7.992
TS0396-2gt-2-13	37.258	0	21.6	28.512	6.966	3.138	2.403	99.877	2.9865	0	2.0408	1.9114	0.473	0.3749	0.2064	7.9931
TS0396-2gt-2-14	37.461	0	21.642	28.682	6.847	2.999	2.486	100.117	2.9947	0	2.0393	1.9176	0.4637	0.3574	0.2129	7.9856
TS0396-2gt-2-15	37.549	0	21.477	28.76	6.861	3.043	2.443	100.133	3.0021	0	2.024	1.9231	0.4646	0.3627	0.2093	7.9858
TS0396-2gt-2-16	37.398	0.041	21.441	28.477	6.831	3.047	2.277	99.512	3.0048	0.0025	2.0306	1.9135	0.4649	0.365	0.196	7.9774
TS0396-2gt-2-17	36.974	0.086	21.433	28.577	6.859	3.038	2.384	99.351	2.9824	0.0052	2.0378	1.9279	0.4686	0.3653	0.2061	7.9933
TS0396-2gt-2-18	37.173	0	21.541	28.829	6.643	3.006	2.381	99.573	2.9897	0	2.0421	1.9392	0.4526	0.3605	0.2052	7.9893
TS0388-gt7a-1-1	36.182	0.015	21.094	32.581	4.022	2.624	1.146	97.664	2.9846	0.0009	2.0509	2.2477	0.281	0.3226	0.1013	7.9891
TS0388-gt7a-1-2	36.861	0	21.469	33.008	4.037	2.745	1.169	99.289	2.9877	0	2.0511	2.2375	0.2772	0.3317	0.1016	7.9869
TS0388-gt7a-1-3	36.956	0.022	21.437	33.533	3.922	2.803	1.162	99.835	2.9836	0.0013	2.0399	2.2641	0.2682	0.3373	0.1005	7.9949
TS0388-gt7a-1-4	36.886	0.027	21.445	33.556	3.876	2.839	1.168	99.797	2.9796	0.0016	2.0418	2.2669	0.2652	0.3418	0.1011	7.9981
TS0388-gt7a-1-5	36.822	0	21.481	33.394	3.808	2.91	1.214	99.629	2.9772	0	2.0472	2.2581	0.2608	0.3507	0.1052	7.9992
TS0388-gt7a-1-6	36.912	0	21.489	33.391	3.766	2.924	1.213	99.695	2.9809	0	2.0455	2.2552	0.2576	0.352	0.105	7.9963
TS0388-gt7a-1-7	36.773	0	21.49	33.549	3.781	2.892	1.191	99.676	2.9737	0	2.0484	2.269	0.259	0.3486	0.1032	8.0019
TS0388-gt7a-1-8	36.891	0.011	21.46	33.742	3.73	2.985	1.23	100.049	2.9734	0.0006	2.0387	2.2744	0.2547	0.3587	0.1062	8.0068
TS0388-gt7a-1-9	36.887	0.037	21.601	33.383	3.685	3.005	1.221	99.819	2.9738	0.0023	2.0526	2.2508	0.2516	0.3612	0.1055	7.9978
TS0388-gt7a-1-10	36.849	0.006	21.463	33.353	3.752	3.03	1.382	99.835	2.9732	0.0004	2.0412	2.2506	0.2564	0.3645	0.1195	8.0058
TS0388-gt7a-2-1	36.975	0	21.375	33.296	3.757	2.975	1.429	99.807	2.9831	0	2.0327	2.2466	0.2567	0.3579	0.1235	8.0005
TS0388-gt7a-2-2	36.859	0.018	21.539	33.478	3.714	3.022	1.417	100.047	2.9686	0.0011	2.0447	2.255	0.2534	0.3628	0.1223	8.0079
TS0388-gt7a-2-3	36.875	0	21.539	33.59	3.631	3.12	1.416	100.171	2.9665	0	2.0424	2.2599	0.2474	0.3742	0.122	8.0124
TS0388-gt7a-2-4	37.129	0.035	21.639	33.395	3.716	3.118	1.39	100.422	2.9746	0.0021	2.0434	2.2375	0.2522	0.3724	0.1194	8.0016
TS0388-gt7a-2-5	37.546	0.014	21.424	33.417	3.741	3.104	1.25	100.496	3.0022	0.0009	2.0192	2.2347	0.2534	0.3699	0.1071	7.9874
TS0388-gt7a-2-6	37.154	0.013	21.459	33.488	3.703	3.2	1.284	100.301	2.9811	0.0008	2.0295	2.2471	0.2517	0.3828	0.1104	8.0035
TS0388-gt7a-2-7	37.353	0.085	21.457	33.247	3.793	3.188	1.364	100.487	2.9882	0.0051	2.0233	2.2244	0.257	0.3801	0.1169	7.995
TS0388-gt7a-2-8	37.116	0.005	21.482	33.123	3.685	3.177	1.333	99.921	2.985	0.0003	2.0364	2.2279	0.251	0.3809	0.1149	7.9964

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0388-gt7a-2-9	37.08	0	21.45	33.603	3.94	3.24	1.343	100.656	2.9705	0	2.0254	2.2513	0.2674	0.3869	0.1153	8.0168
TS0388-gt7a-2-10	37.127	0.038	21.557	33.199	3.827	3.205	1.453	100.406	2.9748	0.0023	2.0359	2.2247	0.2597	0.3828	0.1247	8.0049
TS0388-gt7a-3-1	37.181	0.024	21.607	33.149	3.792	3.2	1.469	100.422	2.9769	0.0014	2.0391	2.2196	0.2571	0.3819	0.126	8.002
TS0388-gt7a-3-2	37.018	0.009	21.57	32.998	3.948	3.165	1.303	100.011	2.9765	0.0005	2.0443	2.219	0.2689	0.3793	0.1123	8.0008
TS0388-gt7a-3-3	37.163	0.027	21.393	32.983	3.96	3.179	1.177	99.882	2.9904	0.0016	2.0291	2.2196	0.2699	0.3813	0.1014	7.9933
TS0388-gt7b-1-1	37.343	0.022	21.598	33.785	4.231	2.31	1.142	100.431	2.9992	0.0013	2.0447	2.2694	0.2878	0.2766	0.0983	7.9773
TS0388-gt7b-1-2	37.268	0	21.59	33.611	4.026	2.66	1.208	100.363	2.9917	0	2.0428	2.2564	0.2738	0.3183	0.1039	7.9869
TS0388-gt7b-1-3	37.204	0.005	21.6	33.777	3.928	2.759	1.236	100.509	2.9839	0.0003	2.042	2.2656	0.2669	0.3299	0.1062	7.9948
TS0388-gt7b-1-4	37.356	0.019	21.395	33.689	3.844	2.843	1.181	100.327	2.9984	0.0012	2.0242	2.2615	0.2614	0.3401	0.1016	7.9885
TS0388-gt7b-1-5	37.543	0.003	21.624	33.376	3.937	2.887	1.171	100.541	3.0009	0.0002	2.0373	2.2311	0.2665	0.344	0.1003	7.9804
TS0388-gt7b-1-6	37.295	0	21.591	33.206	3.73	2.946	1.203	99.971	2.9961	0	2.0445	2.231	0.2538	0.3528	0.1035	7.9818
TS0388-gt7b-1-7	37.268	0	21.545	33.675	3.693	2.969	1.205	100.355	2.9887	0	2.0365	2.2585	0.2509	0.355	0.1035	7.9931
TS0388-gt7b-1-8	37.187	0	21.653	33.522	3.742	2.991	1.221	100.316	2.9823	0	2.0468	2.2484	0.2542	0.3576	0.1049	7.9942
TS0388-gt7b-1-9	37.355	0.043	21.567	33.583	3.706	2.998	1.256	100.508	2.9894	0.0026	2.0344	2.2477	0.2512	0.3576	0.1077	7.9907
TS0388-gt7b-1-10	36.987	0.003	21.573	33.61	3.663	3.075	1.197	100.108	2.9749	0.0002	2.0452	2.2608	0.2496	0.3686	0.1031	8.0024
TS0388-gt7b-2-1	37.302	0.002	21.391	33.546	3.651	3.048	1.191	100.131	2.9962	0.0001	2.0253	2.2535	0.2484	0.365	0.1025	7.9911
TS0388-gt7b-2-2	37.246	0	21.461	33.493	3.712	3.124	1.244	100.28	2.988	0	2.0293	2.2472	0.2522	0.3735	0.107	7.9973
TS0388-gt7b-2-3	37.248	0	21.511	33.434	3.72	3.148	1.211	100.272	2.9872	0	2.0334	2.2424	0.2527	0.3764	0.1041	7.9962
TS0388-gt7b-2-4	37.372	0.014	21.428	33.616	3.717	3.106	1.322	100.575	2.9906	0.0009	2.0211	2.2497	0.252	0.3705	0.1133	7.9982
TS0388-gt7b-2-5	37.525	0	21.547	33.558	3.642	3.082	1.276	100.63	2.9969	0	2.0283	2.2414	0.2463	0.3669	0.1092	7.9891
TS0388-gt7b-2-6	37.286	0.004	21.449	33.453	3.575	3.142	1.3	100.209	2.9912	0.0002	2.0281	2.2445	0.2429	0.3758	0.1118	7.9945
TS0388-gt7b-2-7	37.354	0.015	21.52	33.252	3.642	3.097	1.435	100.315	2.9917	0.0009	2.0316	2.2273	0.2471	0.3698	0.1231	7.9915
TS0388-gt7b-2-8	37.166	0	21.435	33.343	3.668	3.203	1.46	100.295	2.9828	0	2.0267	2.2368	0.2492	0.383	0.1255	8.004
TS0388-gt7b-2-9	37.135	0	21.59	33.24	3.636	3.163	1.423	100.187	2.9795	0	2.0418	2.2305	0.2471	0.3783	0.1223	7.9996
TS0388-gt7b-2-10	37.342	0	21.541	33.405	3.715	3.213	1.406	100.622	2.9843	0	2.0292	2.2327	0.2515	0.3828	0.1204	8.0009
TS0388-gt7b-3-1	37.298	0.022	21.522	33.417	3.741	3.199	1.313	100.512	2.9843	0.0013	2.0298	2.2362	0.2536	0.3816	0.1126	7.9995
TS0388-gt7b-3-2	37.152	0.091	21.45	33.173	3.739	3.216	1.165	99.986	2.9857	0.0055	2.0319	2.2296	0.2545	0.3853	0.1003	7.9928
TS0388-gt7b-3-2	37.102	0	21.519	33.082	3.829	3.191	1.093	99.816	2.9863	0	2.0415	2.2269	0.2611	0.3829	0.0943	7.9931
TS0388-gt7b-3-4	37.127	0.029	21.417	33.401	3.923	3.182	1.071	100.15	2.9838	0.0018	2.0288	2.245	0.2671	0.3812	0.0922	7.9999
TS0388-gt7b-3-5	37.216	0.042	21.412	33.481	3.955	3.154	1.002	100.262	2.9877	0.0025	2.0261	2.2479	0.2689	0.3774	0.0862	7.9967
TS0613-gt6aa-1-1	37.278	0.007	21.484	31.924	4.591	3.136	1.217	99.637	2.9999	0.0004	2.0378	2.1486	0.3129	0.3762	0.1049	7.9808
TS0613-gt6a-1-2	37.26	0.036	21.543	32.454	4.658	3.137	1.218	100.306	2.9861	0.0022	2.035	2.1753	0.3162	0.3748	0.1046	7.9942
TS0613-gt6a-1-3	37.403	0.003	21.443	32.14	4.474	3.295	1.15	99.908	3.0015	0.0002	2.0282	2.1571	0.3041	0.3942	0.0989	7.9842
TS0613-gt6a-1-4	37.6	0	21.541	32.461	4.518	3.287	1.205	100.612	2.999	0	2.0251	2.1653	0.3052	0.3908	0.103	7.9885
TS0613-gt6a-1-5	37.34	0	21.477	32.53	4.395	3.333	1.179	100.254	2.9909	0	2.0278	2.1792	0.2982	0.398	0.1012	7.9954
TS0613-gt6a-1-6	37.202	0	21.541	32.34	4.31	3.474	1.254	100.121	2.982	0	2.0351	2.1679	0.2926	0.4151	0.1077	8.0005
TS0613-gt6a-1-7	37.404	0.02	21.911	32.27	4.259	3.487	1.232	100.583	2.9786	0.0012	2.0566	2.1492	0.2873	0.4139	0.1052	7.9921
TS0613-gt6a-1-8	37.501	0.036	21.597	32.479	4.202	3.547	1.206	100.568	2.9893	0.0022	2.0291	2.1652	0.2837	0.4215	0.103	7.9941
TS0613-gt6a-1-9	37.563	0.048	21.558	32.388	4.125	3.594	1.234	100.51	2.9936	0.0029	2.0251	2.1587	0.2784	0.427	0.1053	7.991
TS0613-gt6a-1-10	37.282	0	21.522	32.21	4.035	3.632	1.272	99.953	2.9876	0	2.0328	2.1587	0.2739	0.4339	0.1092	7.9962
TS0613-gt6a-2-1	37.292	0.013	21.552	32.369	4.109	3.685	1.16	100.18	2.9834	0.0008	2.0323	2.1657	0.2784	0.4395	0.0994	7.9996
TS0613-gt6a-2-2	37.446	0.017	21.693	32.303	4.011	3.673	1.263	100.406	2.9855	0.001	2.0386	2.1539	0.2709	0.4366	0.1079	7.9945
TS0613-gt6a-2-3	37.42	0	21.739	32.279	4.013	3.743	1.21	100.404	2.9827	0	2.0425	2.1518	0.271	0.4447	0.1033	7.9961
TS0613-gt6a-2-4	37.483	0.005	21.762	32.15	3.984	3.72	1.234	100.338	2.9871	0.0003	2.0441	2.1428	0.2689	0.4419	0.1054	7.9905
TS0613-gt6a-2-5	37.337	0	21.583	32.299	3.953	3.754	1.204	100.13	2.9854	0	2.034	2.1599	0.2677	0.4474	0.1032	7.9976
TS0613-gt6a-2-6	37.408	0	21.647	32.131	3.974	3.875	1.296	100.331	2.9828	0	2.0345	2.1427	0.2684	0.4606	0.1108	7.9998
TS0613-gt6a-2-7	37.634	0.015	21.716	32.238	4.07	3.82	1.307	100.8	2.987	0.0009	2.0316	2.1399	0.2736	0.4519	0.1112	7.9962
TS0613-gt6a-2-8	37.341	0.018	21.732	32.114	3.894	3.859	1.305	100.263	2.9786	0.0011	2.0432	2.1424	0.2631	0.4589	0.1115	7.9989
TS0613-gt6a-2-9	37.404	0.002	21.471	32.282	4.036	3.798	1.268	100.261	2.9881	0.0001	2.0218	2.1569	0.2731	0.4523	0.1085	8.0008
TS0613-gt6a-2-10	37.373	0.064	21.71	32.079	3.957	3.825	1.282	100.29	2.9803	0.0038	2.0406	2.1394	0.2673	0.4547	0.1095	7.9957
TS0613-gt6b-1-1	37.09	0.012	21.379	32.082	4.702	3.083	1.202	99.55	2.9932	0.0007	2.0337	2.1653	0.3214	0.3709	0.1039	7.9892
TS0613-gt6b-1-2	37.199	0.018	21.65	32.211	4.698	3.199	1.14	100.115	2.9836	0.0011	2.0468	2.1607	0.3192	0.3825	0.098	7.9919
TS0613-gt6b-1-3	37.289	0	21.406	32.096	4.576	3.278	1.176	99.821	2.9973	0	2.0281	2.1576	0.3116	0.3927	0.1013	7.9886
TS0613-gt6b-1-4	37.483	0.025	21.609	32.542	4.572	3.368	1.2	100.799	2.9866	0.0015	2.0294	2.1685	0.3086	0.4	0.1025	7.9972
TS0613-gt6b-1-5	37.438	0.028	21.728	32.628	4.473	3.37	1.19	100.855	2.981	0.0016	2.0392	2.1728	0.3017	0.4	0.1015	7.9978
TS0613-gt6b-1-6	37.329	0.018	21.604	32.56	4.307	3.422	1.223	100.463	2.9829	0.0011	2.0348	2.1759	0.2916	0.4077	0.1047	7.9987
TS0613-gt6b-1-7	37.334	0.028	21.914	32.229	4.333	3.5	1.17	100.508	2.9758	0.0017	2.0588	2.1484	0.2926	0.4159	0.0999	7.9932
TS0613-gt6b-1-8	37.316	0	21.479	32.307	4.298	3.493	1.207	100.1	2.9899	0	2.0285	2.1649	0.2917	0.4172	0.1036	7.9959
TS0613-gt6b-1-9	37.357	0	21.497	32.482	4.242	3.551	1.206	100.335	2.9872	0	2.0262	2.1723	0.2873	0.4233	0.1034	7.9998
TS0613-gt6b-1-10	37.234	0.018	21.428	32.33	4.152	3.563	1.202	99.927	2.988	0.0011	2.0268	2.1698	0.2823	0.4262	0.1034	7.9976
TS0613-gt6b-2-1	37.077	0.016	21.464	32.277	4.2	3.572	1.191	99.797	2.9805	0.001	2.0337	2.1699	0.286	0.428	0.1026	8.0017
TS0613-gt6b-2-2	37.268	0.026	21.5	32.404	4.187	3.595	1.17	100.148	2.9844	0.0016	2.0295	2.1703	0.284	0.4292	0.1004	7.9994
TS0613-gt6b-2-3	37.451	0	21.722	32.157	4.12	3.665	1.226	100.341	2.9868	0	2.0419	2.1448	0.2783	0.4357	0.1048	7.9923
TS0613-gt6b-2-4	37.322	0	21.705	32.574	4.155	3.666	1.174	100.596	2.9758	0	2.0398	2.1721	0.2806	0.4358	0.1003	8.0044
TS0613-gt6b-2-5	37.195	0.036	21.62	32.357	4.079	3.767	1.239	100.293	2.9731	0.0021	2.0369	2.1631	0.2762	0.4489	0.1061	8.0064
TS0613-gt6b-2-6	37.124	0.019	21.725	32.353	4.119	3.734	1.2	100.274	2.9682	0.0011	2.0474	2.1633	0.279	0.4451	0.1028	8.0069
TS0613-gt6b-2-7	37.155	0	21.49	32.041	3.989	3.664	1.198	99.537	2.9878	0	2.0369	2.1548	0.2717	0.4392	0.1032	7.9936
TS0613-gt6b-2-8	37.376	0	21.56	32.127	4.017	3.653	1.269	100.002	2.9911	0	2.0337	2.1503	0.2723	0.4358	0.1088	7.992
TS0613-gt6b-2-9	37.553	0	21.432	32.298	4.063	3.685	1.177	100.208	3.0001	0	2.0182	2.158	0.275	0.4389	0.1008	7.991
TS0613-gt6b-2-10	37.336	0.022	21.428	32.317	4.082	3.731	1.146	100.062	2.9896	0.0013	2.0224	2.1641	0.2769	0.4453	0.0983	7.998
TS0613-gt6b-2-11	37.455	0.099	21.437	32.072	4.017	3.58	1.219	99.879	2.9998	0.006	2.0237	2.1483	0.2725	0.4275	0.1046	7.9825
TS0613-gt6b-2-12	37.385	0.016	21.62	32.233	4.016	3.651	1.231	100.152	2.988	0.001	2.0368	2.1546	0.2719	0.435	0.1054	7.9927

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0613-gt6b-2-13	37.342	0.021	21.734	32.366	4.034	3.76	1.278	100.535	2.9754	0.0012	2.0413	2.1568	0.2723	0.4466	0.1091	8.0028
TS0396-gt1-1-1	37.136	0.046	21.258	28.328	7.805	2.696	2.16	99.429	2.9996	0.0028	2.0239	1.9137	0.534	0.3246	0.1869	7.9855
TS0396-gt1-1-2	37.072	0.004	21.508	28.46	7.743	2.853	2.127	99.767	2.9843	0.0003	2.0407	1.916	0.528	0.3424	0.1835	7.9952
TS0396-gt1-1-3	37.087	0	21.314	28.376	7.548	2.734	2.118	99.177	3.0004	0	2.0325	1.9199	0.5172	0.3297	0.1836	7.9833
TS0396-gt1-1-4	36.974	0.017	21.591	28.686	7.323	2.977	2.133	99.701	2.9764	0.001	2.0487	1.9313	0.4994	0.3573	0.184	7.9982
TS0396-gt1-1-5	37.36	0.008	21.687	28.656	7.182	3.048	2.113	100.054	2.9902	0.0005	2.0459	1.9181	0.4869	0.3636	0.1812	7.9865
TS0396-gt1-1-6	37.3	0	21.429	28.995	7.194	3.096	2.205	100.219	2.9878	0	2.0233	1.9424	0.4881	0.3697	0.1893	8.0006
TS0396-gt1-1-7	37.328	0.011	21.639	28.678	7.119	3.095	2.219	100.089	2.9875	0.0006	2.0413	1.9195	0.4826	0.3693	0.1903	7.9911
TS0396-gt1-1-8	37.393	0.002	21.536	28.654	6.94	3.167	2.197	99.889	2.9958	0.0001	2.0337	1.9199	0.471	0.3783	0.1886	7.9875
TS0396-gt1-1-9	37.336	0.005	21.227	28.814	6.989	3.139	2.216	99.726	3.0012	0.0003	2.0113	1.9371	0.4759	0.3761	0.1908	7.9928
TS0396-gt1-1-10	37.31	0.018	21.508	29.054	6.905	3.141	2.179	100.115	2.988	0.0011	2.0303	1.946	0.4684	0.3749	0.187	7.9958
TS0396-gt1-2-1	37.631	0	21.289	28.551	6.921	3.164	2.152	99.708	3.0173	0	2.0119	1.9145	0.47	0.3781	0.1849	7.9767
TS0396-gt1-2-2	37.961	0	22.614	28.362	6.706	3.373	2.167	101.183	2.9841	0	2.0953	1.8646	0.4465	0.3952	0.1825	7.9682
TS0396-gt1-2-3	36.584	0.021	22.067	28.063	6.719	3.018	2.216	98.688	2.9613	0.0013	2.1054	1.8998	0.4607	0.3641	0.1922	7.9848
TS0396-gt1-2-4	37.567	0	21.501	28.809	6.814	3.23	2.233	100.154	3.0009	0	2.0245	1.9246	0.4611	0.3847	0.1912	7.9871
TS0396-gt1-2-5	37.48	0.027	21.567	28.731	6.776	3.161	2.193	99.935	2.9992	0.0016	2.0342	1.9228	0.4593	0.377	0.188	7.9822
TS0396-gt1-2-6	37.771	0.021	21.379	28.624	6.832	3.243	2.19	100.06	3.0161	0.0012	2.0122	1.9116	0.4621	0.386	0.1874	7.9767
TS0396-gt1-2-7	37.612	0	21.481	28.842	6.737	3.305	2.037	100.014	3.0061	0	2.0237	1.9279	0.4561	0.3938	0.1745	7.9821
TS0396-gt1-2-8	37.72	0	21.512	29.153	6.744	3.328	2.023	100.48	3.0037	0	2.0191	1.9415	0.4549	0.395	0.1726	7.9868
TS0396-gt1-2-9	37.425	0.027	21.46	28.715	6.766	3.316	2.116	99.825	2.9982	0.0016	2.0265	1.9239	0.4592	0.396	0.1816	7.987
TS0396-gt1-2-10	37.652	0.012	21.419	28.87	6.688	3.415	2.172	100.228	3.0038	0.0007	2.0141	1.9262	0.4519	0.4062	0.1857	7.9886
TS0396-gt1-2-11	37.313	0.006	21.322	28.725	6.636	3.382	2.237	99.621	2.9967	0.0004	2.0184	1.9294	0.4514	0.4049	0.1925	7.9938
TS0396-gt1-2-12	37.524	0	21.544	28.672	6.479	3.405	2.231	99.855	3.0005	0	2.0305	1.9174	0.4389	0.4058	0.1911	7.9843
TS0396-gt1-2-13	37.184	0.012	21.571	28.752	6.493	3.307	2.174	99.493	2.9881	0.0007	2.0432	1.9323	0.442	0.3962	0.1872	7.9898
TS0396-gt1-2-14	37.659	0.057	21.62	28.693	6.678	3.375	2.151	100.233	3.0004	0.0034	2.0303	1.9119	0.4507	0.4006	0.1836	7.9811
TS0396-gt1-2-15	37.347	0.034	21.588	28.722	6.649	3.449	2.229	100.018	2.9858	0.002	2.0344	1.9205	0.4503	0.411	0.191	7.995
TS0397-gt2-1-1	48.677	0	28.46	1.89	0.306	1.104	9.459	89.896	3.6215	0	2.4958	0.1176	0.0193	0.1224	0.754	7.1307
TS0397-gt2-1-2	37.135	0.029	21.428	25.775	9.514	2.01	3.608	99.499	2.9972	0.0018	2.0385	1.7398	0.6505	0.2418	0.312	7.9817
TS0397-gt2-1-3	36.703	0.013	21.117	25.813	8.961	2.219	3.522	98.348	2.9957	0.0008	2.0316	1.762	0.6196	0.27	0.308	7.9878
TS0397-gt2-1-4	36.839	0.054	21.151	26.281	8.699	2.391	3.587	99.002	2.9888	0.0033	2.0226	1.7832	0.5978	0.2891	0.3118	7.9967
TS0397-gt2-1-5	36.771	0	21.365	26.659	8.343	2.563	3.614	99.315	2.974	0	2.0367	1.8032	0.5715	0.309	0.3132	8.0076
TS0397-gt2-1-6	37.036	0.006	21.397	26.286	8.212	2.594	3.556	99.087	2.9922	0.0004	2.0377	1.7761	0.562	0.3124	0.3078	7.9886
TS0397-gt2-1-7	36.961	0	21.365	26.401	7.983	2.769	3.724	99.203	2.9836	0	2.0328	1.7823	0.5459	0.3332	0.3221	7.9999
TS0397-gt2-1-8	37.011	0.015	21.524	26.369	7.715	2.706	3.561	98.901	2.9901	0.0009	2.0496	1.7816	0.528	0.3259	0.3083	7.9844
TS0397-gt2-1-9	35.416	0	19.911	24.061	7.031	2.638	3.333	92.39	3.044	0	2.0172	1.7295	0.5119	0.3379	0.307	7.9475
TS0397-gt2-1-10	33.192	0	18.938	22.843	6.519	2.473	3.905	87.87	3.0091	0	2.0237	1.732	0.5006	0.3342	0.3793	7.9789
TS0397-gt2-2-1	36.398	0	20.975	26.246	7.51	2.817	3.581	97.527	2.9869	0	2.0288	1.8013	0.5221	0.3446	0.3149	7.9987
TS0397-gt2-2-2	36.985	0.012	21.555	26.805	7.713	2.967	3.662	99.699	2.9708	0.0007	2.0408	1.8006	0.5246	0.3553	0.3152	8.0082
TS0397-gt2-2-3	36.978	0	21.568	26.707	7.564	2.99	3.494	99.301	2.9774	0	2.047	1.7985	0.5159	0.3589	0.3015	7.9993
TS0397-gt2-2-4	37.041	0	21.475	26.927	7.44	3.038	3.519	99.44	2.9797	0	2.0363	1.8116	0.507	0.3643	0.3034	8.0023
TS0397-gt2-2-5	36.939	0.006	21.259	26.83	7.25	3.059	3.58	98.923	2.986	0.0004	2.0256	1.8138	0.4964	0.3686	0.3101	8.0009
TS0397-gt2-2-6	37.05	0	21.49	26.719	7.388	2.989	3.61	99.246	2.9834	0	2.0397	1.7994	0.5039	0.3588	0.3115	7.9968
TS0397-gt2-2-7	37.231	0	21.551	27.045	7.228	3.111	3.543	99.709	2.9836	0	2.0357	1.8126	0.4907	0.3716	0.3042	7.9984
TS0397-gt2-2-8	37.18	0.025	21.676	26.945	7.033	3.132	3.632	99.623	2.9789	0.0015	2.047	1.8055	0.4773	0.3741	0.3118	7.9962
TS0397-gt2-2-9	37.23	0.014	21.455	26.805	7.116	3.085	3.671	99.376	2.9905	0.0009	2.0314	1.8007	0.4841	0.3694	0.3159	7.9929
TS0397-gt2-2-10	37.257	0.02	21.561	26.736	6.99	3.124	3.68	99.368	2.9896	0.0012	2.0393	1.7943	0.4751	0.3736	0.3164	7.9896
TS0397-gt2-3-1	37.008	0.007	21.435	27.013	6.964	3.127	3.719	99.273	2.9793	0.0004	2.0339	1.8187	0.4749	0.3752	0.3208	8.0032
TS0397-gt2-3-2	37.14	0	21.397	26.988	6.918	3.181	3.506	99.13	2.9904	0	2.0306	1.8173	0.4718	0.3818	0.3025	7.9945
TS0397-gt2-3-3	37.036	0	21.377	27.455	6.801	3.198	3.383	99.25	2.9831	0	2.0296	1.8495	0.464	0.384	0.292	8.0022
TS0287-gt1-1-1	36.528	0	21	25.708	12.262	1.882	1.667	99.047	2.9887	0	2.0252	1.7592	0.8499	0.2295	0.1461	7.9987
TS0287-gt1-1-2	36.831	0	21.192	26.8	11.095	2.26	1.496	99.674	2.988	0	2.0265	1.8184	0.7625	0.2734	0.13	7.9988
TS0287-gt1-1-3	36.648	0	21.117	27.337	10.847	2.378	1.425	99.752	2.9764	0	2.0215	1.8568	0.7462	0.2879	0.124	8.0128
TS0287-gt1-1-4	36.769	0.032	21.073	27.002	10.474	2.381	1.517	99.248	2.9919	0.002	2.0211	1.8375	0.7219	0.2888	0.1323	7.9956
TS0287-gt1-1-5	36.63	0.053	21.331	27.048	10.542	2.404	1.505	99.513	2.974	0.0032	2.0413	1.8366	0.725	0.291	0.131	8.0021
TS0287-gt1-1-6	36.759	0.028	21.188	26.998	10.562	2.446	1.563	99.544	2.9831	0.0017	2.0267	1.8324	0.7261	0.2959	0.1359	8.0018
TS0287-gt1-1-7	36.673	0.016	21.14	26.831	10.507	2.447	1.623	99.237	2.9842	0.001	2.0275	1.8259	0.7242	0.2968	0.1415	8.0011
TS0287-gt1-1-8	36.727	0.005	21.155	27.012	10.69	2.45	1.594	99.633	2.9805	0.0003	2.0236	1.8333	0.7348	0.2964	0.1386	8.0075
TS0287-gt1-1-9	36.775	0.078	21.084	26.933	10.734	2.506	1.588	99.698	2.9818	0.0048	2.015	1.8263	0.7372	0.3029	0.1379	8.0059
TS0287-gt1-1-10	36.804	0.04	21.322	27.097	10.622	2.503	1.518	99.906	2.9764	0.0025	2.0325	1.8327	0.7276	0.3017	0.1316	8.005
TS0287-gt1-2-1	36.844	0.048	21.159	26.487	10.7	2.403	1.555	99.196	2.9947	0.003	2.0271	1.8006	0.7367	0.2911	0.1355	7.9887
TS0287-gt1-2-2	36.882	0.004	21.117	26.81	10.869	2.472	1.625	99.779	2.9872	0.0002	2.016	1.816	0.7457	0.2985	0.141	8.0047
TS0287-gt1-2-3	36.758	0.008	21.18	26.73	10.757	2.442	1.625	99.5	2.984	0.0005	2.0266	1.8147	0.7397	0.2955	0.1413	8.0023
TS0287-gt1-2-4	36.732	0.017	21.211	26.796	10.883	2.348	1.673	99.66	2.98	0.001	2.0283	1.8181	0.7479	0.284	0.1454	8.0047
TS0287-gt1-2-5	36.749	0.015	21.164	26.628	11.036	2.34	1.616	99.548	2.9841	0.0009	2.0257	1.8084	0.7591	0.2833	0.1406	8.0021
TS0287-gt1-2-6	36.783	0.032	21.162	26.374	10.897	2.299	1.851	99.398	2.9879	0.002	2.0262	1.7917	0.7498	0.2784	0.1611	7.9971
TS0287-gt1-2-7	36.881	0.063	21.167	26.371	11.085	2.36	1.804	99.731	2.9868	0.0038	2.0205	1.7861	0.7604	0.2849	0.1565	7.999
TS0287-gt1-2-8	36.697	0.028	21.193	26.653	11.235	2.344	1.833	99.983	2.972	0.0017	2.023	1.8053	0.7707	0.283	0.1591	8.0148
TS0287-gt1-2-9	36.76	0.069	21.186	26.285	11.021	2.34	1.886	99.547	2.9824	0.0042	2.026	1.7835	0.7574	0.283	0.1639	8.0004
TS0287-gt1-2-10	35.878	0.072	21.451	24.864	9.7	3.465	1.623	97.053	2.9548	0.0045	2.0823	1.7125	0.6767	0.4255	0.1432	7.9995
TS0287-gt1-2-11	36.9	0.015	21.054	26.243	11.222	2.274	1.917	99.625	2.993	0.0009	2.0129	1.7802	0.771	0.2749	0.1666	7.9995
TS0287-gt1-3-1	36.774	0.047	21.313	25.949	11.211	2.252	1.893	99.439	2.984	0.0029	2.0385	1.7609	0.7706	0.2724	0.1646	7.9939
TS0287-gt1-3-2	36.479	0.061	21.304	25.792	11.438	2.165	2.132	99.371	2.968	0.0038	2.0431	1.755	0.7883	0.2626	0.1858	8.0066

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO$_2$	TiO$_2$	Al$_2$O$_3$	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0287-gt1-3-3	36.409	0.025	21.238	25.623	11.597	2.179	1.722	98.793	2.9772	0.0016	2.047	1.7523	0.8032	0.2656	0.1508	7.9977
TS0287-gt1-3-4	36.568	0.021	21.239	25.709	11.821	2.289	1.546	99.193	2.979	0.0013	2.0394	1.7516	0.8157	0.278	0.135	8
TS0287-gt2-1-1	36.735	0.034	21.107	25.624	12.151	1.912	1.811	99.374	2.9916	0.0021	2.026	1.7452	0.8382	0.2321	0.1581	7.9934
TS0287-gt2-1-2	36.728	0	21.244	26.171	11.496	2.099	1.742	99.48	2.9853	0	2.0353	1.779	0.7915	0.2543	0.1517	7.9971
TS0287-gt2-1-3	36.56	0.008	21.175	26.487	11.184	2.274	1.588	99.276	2.9787	0.0005	2.0335	1.8048	0.7719	0.2761	0.1386	8.0042
TS0287-gt2-1-4	36.542	0.047	21.164	26.786	10.817	2.37	1.576	99.302	2.9757	0.0029	2.0314	1.8242	0.7461	0.2877	0.1376	8.0056
TS0287-gt2-1-5	35.842	0	20.831	26.755	10.263	2.265	1.5	97.456	2.9751	0	2.0381	1.8574	0.7216	0.2803	0.1334	8.0059
TS0287-gt2-1-6	36.252	0	21.1	27.001	10.38	2.418	1.468	98.619	2.9723	0	2.0391	1.8514	0.7209	0.2956	0.1289	8.0082
TS0287-gt2-1-7	35.526	0.127	20.398	25.562	9.863	2.328	1.437	95.241	3.0011	0.0081	2.0311	1.806	0.7058	0.2932	0.1301	7.9755
TS0287-gt2-1-8	35.652	0.025	20.378	25.616	9.86	2.353	1.504	95.388	3.0072	0.0016	2.026	1.8071	0.7045	0.2959	0.1359	7.9783
TS0287-gt2-1-9	35.808	0	20.493	25.647	9.961	2.368	1.488	95.765	3.0078	0	2.029	1.8017	0.7087	0.2965	0.1339	7.9777
TS0287-gt2-1-10	35.635	0.029	20.606	25.88	10.01	2.366	1.593	96.119	2.9882	0.0018	2.0367	1.815	0.711	0.2958	0.1432	7.9917
TS0287-gt2-1-11	35.911	0.027	20.866	26.619	10.215	2.428	1.539	97.605	2.9732	0.0017	2.0363	1.8431	0.7164	0.2997	0.1365	8.0069
TS0287-gt2-2-1	35.96	0	21.041	26.725	10.217	2.396	1.573	97.912	2.9681	0	2.0471	1.8448	0.7143	0.2949	0.1391	8.0084
TS0287-gt2-2-2	35.073	0	20.16	25.024	9.421	2.337	1.487	93.502	3.0111	0	2.0401	1.7968	0.6851	0.299	0.1368	7.969
TS0287-gt2-2-3	35.33	0	20.302	25.534	9.745	2.384	1.532	94.827	2.9992	0	2.0314	1.8128	0.7007	0.3017	0.1393	7.9851
TS0287-gt2-2-4	35.556	0.03	20.518	25.361	9.72	2.346	1.524	95.055	3.0046	0.0019	2.0437	1.7923	0.6957	0.2956	0.138	7.9719
TS0287-gt2-2-5	35.416	0.004	20.336	25.446	9.78	2.354	1.48	94.816	3.0045	0.0002	2.0335	1.8053	0.7028	0.2977	0.1346	7.9786
TS0287-gt2-2-6	35.609	0	20.447	25.693	9.827	2.38	1.491	95.447	3.0023	0	2.032	1.8117	0.7018	0.2992	0.1347	7.9818
TS0287-gt2-2-7	35.606	0	20.501	25.517	9.995	2.408	1.459	95.486	3.0001	0	2.0361	1.7981	0.7134	0.3024	0.1318	7.9819
TS0287-gt2-2-8	35.364	0.035	20.318	25.618	9.846	2.451	1.527	95.159	2.9936	0.0022	2.0272	1.8137	0.706	0.3093	0.1385	7.9905
TS0220-gt1-1-1	37.037	0	21.236	32.392	5.129	3.141	0.821	99.756	2.9905	0	2.0211	2.1874	0.3508	0.378	0.071	7.9989
TS0220-gt1-1-2	37.194	0	21.133	32.406	5.117	3.217	0.818	99.885	2.9983	0	2.008	2.1847	0.3494	0.3866	0.0707	7.9978
TS0220-gt1-1-3	37.046	0.032	21.239	32.522	5.055	3.202	0.837	99.933	2.9867	0.0019	2.0183	2.1928	0.3452	0.3848	0.0723	8.0021
TS0220-gt1-1-4	37.034	0	21.131	32.628	5.043	3.162	0.863	99.861	2.9901	0	2.011	2.2032	0.3449	0.3805	0.0746	8.0043
TS0220-gt1-1-5	37.002	0	21.193	32.481	5.169	3.208	0.92	99.973	2.9844	0	2.0147	2.1909	0.3531	0.3857	0.0795	8.0083
TS0220-gt1-1-6	37.134	0.038	21.064	32.481	5.095	3.131	0.887	99.83	2.9974	0.0023	2.0041	2.1927	0.3484	0.3767	0.0767	7.9983
TS0220-gt1-1-7	36.897	0.06	21.287	32.383	5.218	3.095	0.921	99.861	2.9791	0.0036	2.0259	2.1866	0.3568	0.3725	0.0797	8.0042
TS0220-gt1-1-8	37.215	0.015	21.25	32.563	5.137	3.069	0.98	100.229	2.9925	0.0009	2.0141	2.1899	0.3499	0.3679	0.0844	7.9997
TS0220-gt1-1-9	37.176	0.012	21.182	32.391	5.174	3.161	0.975	100.071	2.993	0.0007	2.0101	2.1809	0.3529	0.3794	0.0841	8.0012
TS0220-gt1-1-10	37.111	0	21.197	32.403	4.993	3.222	0.95	99.876	2.9918	0	2.0142	2.1847	0.341	0.3873	0.0821	8.0012
TS0220-gt1-2-1	37.054	0.018	21.254	32.651	4.821	3.285	0.903	99.986	2.9849	0.0011	2.018	2.1997	0.3289	0.3945	0.0779	8.005
TS0220-gt1-2-2	37.075	0.028	21.367	32.6	4.654	3.476	0.808	100.008	2.9814	0.0017	2.0253	2.1925	0.317	0.4167	0.0696	8.0042
TS0220-gt1-2-3	37.076	0.036	21.381	32.592	4.529	3.667	0.888	100.169	2.9756	0.0022	2.0226	2.1875	0.3079	0.4388	0.0764	8.011
TS0220-gt1-2-4	37.122	0	21.336	32.234	4.374	3.676	0.826	99.568	2.9898	0	2.0255	2.1712	0.2984	0.4413	0.0713	7.9975
TS0220-gt1-2-5	37.18	0.009	21.317	32.471	4.351	3.752	0.827	99.907	2.9867	0.0005	2.0184	2.1815	0.2961	0.4493	0.0712	8.0037
TS0220-gt1-2-6	37.142	0.036	21.242	32.331	4.368	3.817	0.875	99.811	2.9861	0.0022	2.0129	2.1738	0.2975	0.4574	0.0754	8.0054
TS0220-gt1-2-7	37.155	0	21.316	32.348	4.388	3.73	0.87	99.807	2.9871	0	2.02	2.175	0.2988	0.447	0.0749	8.0028
TS0220-gt1-2-8	37.067	0.03	21.2	32.28	4.329	3.854	0.913	99.673	2.9842	0.0018	2.0119	2.1735	0.2952	0.4626	0.0788	8.008
TS0220-gt1-2-9	37.15	0	21.347	32.65	4.297	3.874	0.884	100.202	2.9777	0	2.0168	2.1887	0.2918	0.4629	0.0759	8.0138
TS0220-gt1-2-10	37.238	0	21.366	32.471	4.271	3.702	0.821	99.869	2.9905	0	2.0225	2.1808	0.2905	0.4432	0.0707	7.9983
TS0220-gt2-1-1	37.225	0	21.226	32.304	5.239	3.013	0.866	99.873	3.001	0	2.0169	2.178	0.3578	0.3621	0.0748	7.9907
TS0220-gt2-1-2	36.921	0.023	21.102	32.668	5.151	3.101	0.852	99.818	2.9854	0.0014	2.0112	2.2091	0.3528	0.3738	0.0739	8.0076
TS0220-gt2-1-3	36.952	0.027	21.229	32.381	5.024	3.229	0.857	99.699	2.9851	0.0016	2.0214	2.1877	0.3438	0.3888	0.0742	8.0026
TS0220-gt2-1-4	37.111	0	21.29	32.545	4.796	3.307	0.907	99.956	2.9879	0	2.0204	2.1914	0.3271	0.3969	0.0783	8.002
TS0220-gt2-1-5	37.093	0.016	21.278	32.499	4.726	3.485	0.876	99.973	2.9845	0.0009	2.0179	2.1868	0.3221	0.418	0.0755	8.0057
TS0220-gt2-1-6	37.133	0	21.375	32.415	4.641	3.549	0.825	99.938	2.9851	0	2.0254	2.1793	0.316	0.4253	0.0711	8.0022
TS0220-gt2-1-7	37.364	0.005	21.339	32.469	4.605	3.525	0.873	100.18	2.9949	0.0003	2.0161	2.1766	0.3126	0.4212	0.075	7.9968
TS0220-gt2-1-8	37.17	0.029	21.331	32.516	4.588	3.667	0.849	100.15	2.9825	0.0017	2.0174	2.182	0.3119	0.4386	0.073	8.0071
TS0220-gt2-1-9	37.168	0.046	21.306	32.192	4.54	3.583	0.928	99.763	2.9898	0.0028	2.0201	2.1657	0.3093	0.4297	0.08	7.9974
TS0220-gt2-1-10	37.222	0	21.426	32.545	4.445	3.673	0.888	100.199	2.983	0	2.0239	2.1813	0.3017	0.4388	0.0762	8.0049
TS0220-gt2-2-1	37.228	0	21.255	32.473	4.397	3.69	0.899	99.942	2.9906	0	2.0125	2.1816	0.2992	0.4419	0.0774	8.0033
TS0220-gt2-2-2	37.273	0.01	21.132	32.412	4.463	3.675	0.877	99.842	2.9973	0.0006	2.003	2.1798	0.304	0.4405	0.0756	8.0008
TS0220-gt2-2-3	36.98	0.071	21.187	32.436	4.384	3.686	0.879	99.623	2.9822	0.0043	2.0139	2.1876	0.2995	0.4431	0.0759	8.0065
TS0220-gt2-2-4	37.071	0.039	21.124	32.508	4.184	3.74	0.901	99.567	2.9892	0.0024	2.0077	2.1922	0.2858	0.4496	0.0779	8.0048
TS0220-gt2-2-5	37.144	0.018	21.49	32.371	4.232	3.782	0.963	100	2.9787	0.0011	2.0313	2.1711	0.2874	0.4521	0.0828	8.0045
TS0220-gt2-2-6	37.188	0.05	21.255	32.672	4.312	3.804	0.956	100.237	2.9809	0.003	2.0082	2.1903	0.2928	0.4545	0.0821	8.0118
TS0220-gt2-2-7	37.022	0.015	21.377	32.613	4.305	3.839	0.929	100.1	2.9717	0.0009	2.0224	2.1893	0.2927	0.4593	0.0799	8.0162
TS0244-gt1-1-1	36.947	0	21.261	29.741	7.671	2.723	1.138	99.481	2.993	0	2.0301	2.0149	0.5264	0.3288	0.0988	7.992
TS0244-gt1-1-2	37.075	0.038	21.106	29.905	7.268	2.986	1.234	99.612	2.9967	0.0023	2.0108	2.0215	0.4976	0.3598	0.1069	7.9957
TS0244-gt1-1-3	36.862	0	21.034	30.391	7.019	3.095	1.226	99.627	2.9847	0	2.0075	2.058	0.4814	0.3736	0.1063	8.0115
TS0244-gt1-1-4	37.044	0.031	21.201	29.652	7.057	3.099	1.221	99.305	2.997	0.0019	2.0218	2.0063	0.4836	0.3737	0.1058	7.9901
TS0244-gt1-1-5	37.162	0.056	21.249	30.124	7.046	3.188	1.212	100.037	2.9891	0.0034	2.0146	2.0264	0.4801	0.3822	0.1045	8.0003
TS0244-gt1-1-6	36.993	0.043	21.27	30.171	7.08	3.306	1.158	100.021	2.9782	0.0026	2.0183	2.0314	0.4828	0.3968	0.0999	8.01
TS0244-gt1-1-7	37.009	0	21.147	30.005	7.024	3.211	1.123	99.519	2.9919	0	2.015	2.0286	0.481	0.3869	0.0972	8.0006
TS0244-gt1-1-8	37.154	0	21.293	30.298	6.918	3.195	1.088	99.946	2.9906	0	2.0202	2.0396	0.4717	0.3833	0.0938	7.9993
TS0174-gt2-1-1	36.903	0	21.418	30.169	6.846	2.524	2.077	99.937	2.9782	0	2.0374	2.0362	0.468	0.3036	0.1796	8.003
TS0174-gt2-1-2	36.982	0	21.16	30.171	6.61	2.667	2.193	99.783	2.9877	0	2.015	2.0385	0.4524	0.3212	0.1899	8.0048
TS0174-gt2-1-3	37.02	0.022	21.016	30.266	6.422	2.732	2.181	99.659	2.9937	0.0013	2.0032	2.0469	0.4399	0.3294	0.189	8.0034
TS0174-gt2-1-4	37.046	0	21.166	30.071	6.289	2.69	2.082	99.344	2.999	0	2.0197	2.0359	0.4313	0.3247	0.1806	7.9913
TS0174-gt2-1-5	37.103	0.039	21.14	29.993	6.447	2.692	2.151	99.565	2.9982	0.0023	2.0135	2.0269	0.4413	0.3243	0.1862	7.9927
TS0174-gt2-1-6	36.832	0.024	21.089	30.068	6.207	2.767	2.33	99.317	2.9861	0.0014	2.0153	2.0388	0.4262	0.3345	0.2024	8.0047

Appendix 1 Mineral Chemistry

Garnet Chemistry

	Weight percent oxide								Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0174-gt2-1-7	36.892	0	21.107	30.238	6.18	2.827	2.442	99.686	2.9821	0	2.011	2.0441	0.4231	0.3407	0.2115	8.0125
TS0174-gt2-1-8	37.192	0.06	21.136	30.049	6.291	2.728	2.413	99.869	2.9962	0.0036	2.007	2.0246	0.4293	0.3276	0.2083	7.9967
TS0174-gt2-1-9	37.033	0.064	21.006	30.339	6.385	2.772	2.33	99.929	2.9883	0.0039	1.9979	2.0475	0.4364	0.3335	0.2015	8.009
TS0174-gt2-1-10	36.977	0.028	21.224	30.313	6.247	2.729	2.371	99.869	2.9826	0.0017	2.0178	2.0448	0.4268	0.3281	0.205	8.0068
TS0174-gt2-2-1	37.33	0.04	21.129	30.423	6.094	2.807	2.428	100.251	2.997	0.0024	1.9995	2.0427	0.4144	0.336	0.2089	8.0009
TS0174-gt2-2-2	37.107	0.003	21.243	30.397	6.107	2.808	2.287	99.952	2.9883	0.0002	2.0165	2.0473	0.4166	0.3371	0.1974	8.0034
TS0174-gt2-2-3	37.167	0.052	21.107	30.629	5.823	2.898	2.461	100.137	2.9886	0.0031	2.0005	2.0598	0.3966	0.3473	0.2121	8.008
TS0174-gt2-2-4	36.998	0.033	21.107	30.705	5.311	3.041	2.542	99.737	2.9838	0.002	2.0064	2.0709	0.3628	0.3655	0.2197	8.0112
TS0174-gt2-2-5	37.031	0.075	21.253	30.588	5.302	3.032	2.505	99.786	2.9818	0.0045	2.0172	2.0599	0.3616	0.364	0.2161	8.0051
TS0174-gt2-2-6	47.668	0.002	16.133	25.095	4.275	2.34	2.021	97.534	3.7114	0.0001	1.4806	1.6341	0.282	0.2716	0.1686	7.5485
TS0174-gt2-2-7	37.138	0.032	21.208	30.368	5.25	3.016	2.745	99.757	2.9889	0.002	2.0118	2.044	0.3579	0.3618	0.2367	8.0031
TS0174-gt3-1-1	37.123	0	21.205	30.452	6.67	2.462	1.952	99.864	2.9975	0	2.0181	2.0564	0.4562	0.2963	0.1689	7.9934
TS0174-gt3-1-2	37.222	0.009	21.011	30.97	6.332	2.691	2.028	100.263	2.9966	0.0005	1.9938	2.0853	0.4318	0.3229	0.175	8.0059
TS0174-gt3-1-3	37.019	0.036	21.321	30.592	6.239	2.766	2.021	99.994	2.9825	0.0022	2.0247	2.0612	0.4258	0.3322	0.1745	8.0031
TS0174-gt3-1-4	37.278	0	21.427	30.591	6.048	2.761	2.417	100.522	2.9852	0	2.0224	2.0488	0.4102	0.3296	0.2074	8.0036
TS0174-gt3-1-5	37.053	0.007	21.232	30.97	6.064	2.895	2.303	100.524	2.9746	0.0004	2.0091	2.0794	0.4124	0.3465	0.1981	8.0205
TS0174-gt3-1-6	37.436	0	21.458	30.697	5.622	2.836	2.551	100.6	2.9908	0	2.0206	2.051	0.3804	0.3377	0.2183	7.9989
TS0174-gt3-1-7	37.241	0.075	21.074	30.778	5.392	2.984	2.633	100.177	2.9906	0.0046	1.9947	2.067	0.3667	0.3573	0.2266	8.0075
TS0174-gt3-1-8	37.179	0	21.275	30.728	5.415	2.967	2.68	100.244	2.9832	0	2.0121	2.062	0.3681	0.3549	0.2304	8.0107
TS0174-gt3-1-9	37.29	0.054	21.133	30.709	5.323	2.959	2.588	100.056	2.9952	0.0033	2.0008	2.0629	0.3621	0.3542	0.2227	8.0012
TS0174-gt3-1-10	37.083	0.064	21.334	30.592	5.244	3.073	2.606	99.996	2.9789	0.0039	2.02	2.0553	0.3568	0.368	0.2243	8.0072
TS0174-gt3-2-1	37.19	0.004	21.274	30.766	5.259	3.023	2.591	100.107	2.9858	0.0003	2.0132	2.0657	0.3576	0.3618	0.2229	8.0073
TS0174-gt3-2-2	37.15	0.037	21.313	30.581	5.423	2.98	2.519	100.003	2.985	0.0022	2.0185	2.055	0.3691	0.3569	0.2169	8.0036
TS0174-gt3-2-3	37.17	0.048	21.184	30.69	5.518	2.983	2.416	100.009	2.9887	0.0029	2.0077	2.0638	0.3758	0.3576	0.2081	8.0047
TS0174-gt3-2-4	37.112	0.036	21.112	31.019	5.671	2.864	2.375	100.189	2.9856	0.0022	2.0019	2.087	0.3864	0.3434	0.2047	8.0112
TS0174-gt3-2-5	36.962	0.023	21.237	30.588	5.893	2.836	2.219	99.758	2.9831	0.0014	2.0203	2.0646	0.4029	0.3412	0.1919	8.0054
TS0293-gt1-1-1	12.012	0	9.997	27.405	4.2	1.597	1.016	56.227	2.012	0	1.9736	3.8388	0.5959	0.3986	0.1824	9.0013
TS0293-gt1-1-2	36.747	0.077	20.991	32.946	4.468	2.545	1.763	99.537	2.9846	0.0047	2.0096	2.2379	0.3074	0.3082	0.1534	8.0058
TS0293-gt1-1-3	36.72	0.061	21.136	32.597	4.611	2.596	1.668	99.389	2.9828	0.0037	2.0237	2.2145	0.3173	0.3144	0.1452	8.0016
TS0293-gt1-1-4	36.771	0.029	21.158	32.666	4.683	2.656	1.608	99.571	2.9822	0.0018	2.0226	2.2156	0.3217	0.3212	0.1397	8.0049
TS0293-gt1-1-5	36.933	0.016	21.219	32.697	4.927	2.727	1.568	100.087	2.981	0.001	2.0187	2.2072	0.3369	0.3282	0.1357	8.0087
TS0293-gt1-1-6	36.883	0.045	21.04	31.951	5.243	2.703	1.677	99.542	2.99	0.0028	2.0105	2.1663	0.3601	0.3267	0.1456	8.002
TS0293-gt1-1-7	36.598	0	21.263	32.063	5.289	2.638	1.714	99.565	2.9703	0	2.0341	2.1763	0.3636	0.3191	0.149	8.0124
TS0293-gt1-1-8	36.524	0	21.195	31.744	5.589	2.596	1.763	99.411	2.9702	0	2.0316	2.159	0.385	0.3147	0.1536	8.0142
TS0293-gt1-1-9	36.961	0.045	21.102	31.663	5.6	2.583	1.699	99.653	2.9929	0.0028	2.0141	2.1442	0.3841	0.3118	0.1474	7.9974
TS0293-gt1-1-10	36.684	0.007	21.142	31.438	5.916	2.495	1.744	99.426	2.9814	0.0004	2.0253	2.1369	0.4073	0.3023	0.1518	8.0054
TS0293-gt1-2-1	36.96	0.022	21.226	31.092	6.189	2.533	1.672	99.694	2.9908	0.0013	2.0245	2.1042	0.4242	0.3056	0.1449	7.9955
TS0293-gt1-2-2	36.71	0.036	20.967	30.795	6.563	2.501	1.612	99.184	2.9904	0.0022	2.0131	2.098	0.4528	0.3037	0.1407	8.0009
TS0293-gt1-2-3	36.726	0	21.142	30.608	6.758	2.482	1.625	99.341	2.986	0	2.0261	2.0812	0.4654	0.3008	0.1415	8.001
TS0293-gt1-2-4	36.767	0.03	20.99	30.739	6.861	2.47	1.581	99.438	2.9895	0.0019	2.0116	2.0903	0.4725	0.2994	0.1377	8.0029
TS0293-gt1-2-5	36.77	0.055	20.971	30.545	7.083	2.504	1.582	99.51	2.9879	0.0033	2.0086	2.0758	0.4876	0.3033	0.1378	8.0043
TS0293-gt1-2-6	36.656	0.048	21.071	30.196	7.193	2.429	1.521	99.114	2.9875	0.0029	2.0242	2.0582	0.4965	0.2952	0.1328	7.9974
TS0293-gt1-2-7	36.441	0.023	21.043	30.058	7.283	2.413	1.622	98.883	2.9795	0.0014	2.028	2.0554	0.5044	0.2941	0.1421	8.0049
TS0293-gt1-2-8	36.588	0.042	21.021	30.041	7.41	2.347	1.6	99.049	2.9864	0.0026	2.0224	2.0507	0.5123	0.2855	0.1399	7.9998
TS0293-gt1-2-9	36.754	0.024	20.887	30.15	7.526	2.4	1.642	99.383	2.9922	0.0015	2.0043	2.0528	0.519	0.2912	0.1433	8.0043
TS0293-gt1-2-10	36.835	0.004	21.092	29.98	7.505	2.364	1.526	99.306	2.9956	0.0003	2.0218	2.039	0.517	0.2866	0.133	7.9934
TS0293-gt1-2-11	36.734	0	21.078	30.106	7.448	2.378	1.479	99.223	2.9915	0	2.0233	2.0505	0.5138	0.2886	0.1291	7.9969
TS0293-gt2-1-1	36.787	0	21.062	32.827	4.425	2.616	1.641	99.358	2.9893	0	2.0174	2.231	0.3046	0.3169	0.1429	8.0021
TS0293-gt2-1-2	36.909	0.045	21.176	32.852	4.49	2.667	1.655	99.794	2.9855	0.0028	2.019	2.2224	0.3077	0.3216	0.1434	8.0024
TS0293-gt2-1-3	36.769	0.079	21.153	32.523	4.86	2.766	1.697	99.847	2.975	0.0048	2.0173	2.2007	0.3331	0.3336	0.1471	8.0116
TS0293-gt2-1-4	36.911	0.03	21.268	32.426	4.966	2.785	1.661	100.047	2.9782	0.0018	2.0227	2.188	0.3394	0.3349	0.1436	8.0086
TS0293-gt2-1-5	36.903	0	21.019	32.29	5.03	2.68	1.684	99.606	2.9915	0	2.0083	2.1891	0.3454	0.3239	0.1462	8.0044
TS0293-gt2-1-6	36.667	0.034	21.349	31.803	5.227	2.692	1.671	99.443	2.9738	0.0021	2.0408	2.1572	0.3591	0.3254	0.1452	8.0036
TS0293-gt2-1-7	36.817	0.051	21.237	32.143	5.241	2.713	1.647	99.849	2.9773	0.0031	2.0242	2.1739	0.359	0.3271	0.1427	8.0073
TS0293-gt2-1-8	36.857	0.005	21.111	31.767	5.41	2.581	1.697	99.428	2.9912	0.0003	2.0195	2.1561	0.3719	0.3122	0.1476	7.9989
TS0293-gt2-1-9	36.908	0.023	21.408	31.626	5.427	2.641	1.661	99.694	2.9832	0.0014	2.0395	2.1378	0.3716	0.3183	0.1439	7.9957
TS0293-gt2-1-10	36.642	0	20.746	31.609	5.571	2.458	1.766	98.792	2.9978	0	2.0006	2.1628	0.3861	0.2997	0.1548	8.0018
TS0293gt2-2-1	36.749	0.008	21.094	31.278	5.874	2.45	1.684	99.137	2.9919	0.0005	2.0242	2.1296	0.4051	0.2974	0.1469	7.9956
TS0293gt2-2-2	36.472	0	21.008	31.456	5.942	2.448	1.65	98.976	2.9804	0	2.0235	2.1498	0.4113	0.2983	0.1445	8.0078
TS0293gt2-2-3	35.332	0.001	20.802	30.606	5.817	2.548	1.535	96.641	2.9564	0.0001	2.0517	2.1418	0.4123	0.3178	0.1376	8.0177
TS0293gt2-2-4	36.682	0	20.93	31.118	6.198	2.415	1.676	99.019	2.9936	0	2.0134	2.1239	0.4284	0.2938	0.1465	7.9997
TS0293gt2-2-5	36.789	0	20.926	31.103	6.267	2.461	1.776	99.322	2.9936	0	2.0071	2.1167	0.432	0.2986	0.1549	8.0029
TS0293gt2-2-6	36.567	0.051	21.069	30.786	6.368	2.475	1.64	98.956	2.9841	0.0031	2.0266	2.1011	0.4402	0.3011	0.1434	7.9997
TS0293gt2-2-7	36.811	0.013	20.936	31.041	6.522	2.45	1.7	99.473	2.9925	0.0008	2.0061	2.1104	0.4491	0.2968	0.148	8.0037
TS0293gt2-2-8	36.426	0.05	21.213	30.877	6.59	2.395	1.674	99.225	2.9694	0.0031	2.0383	2.1051	0.4551	0.2911	0.1462	8.0083
TS0293gt2-2-9	36.564	0.013	21.036	30.635	6.643	2.403	1.544	98.838	2.9884	0.0008	2.0265	2.094	0.4599	0.2928	0.1353	7.9977
TS0293gt2-2-10	36.802	0.023	20.882	30.46	6.842	2.369	1.546	98.944	3.0033	0.0014	2.0086	2.0789	0.4729	0.2907	0.1352	7.9911
TS0293gt2-2-11	36.626	0.01	21.165	30.696	6.808	2.414	1.561	99.28	2.9818	0.0006	2.031	2.09	0.4695	0.2929	0.1362	8.002
TS0293gt2-2-12	36.431	0	21.036	30.601	6.825	2.398	1.561	98.852	2.9805	0	2.0285	2.0938	0.473	0.2924	0.1369	8.0051
TS0293gt2-2-13	28.847	0.017	18.695	29.433	6.736	1.907	1.566	87.201	2.7557	0.0012	2.1051	2.3516	0.545	0.2716	0.1603	8.1905
TS0293gt2-2-14	36.449	0.035	20.952	30.351	6.955	2.364	1.502	98.608	2.9876	0.0021	2.0242	2.0806	0.4829	0.2889	0.1319	7.9983
TS0293gt2-2-15	36.407	0.057	20.939	30.326	7.018	2.426	1.555	98.728	2.9819	0.0035	2.0215	2.0773	0.4869	0.2962	0.1365	8.0038

Appendix 1 Mineral Chemistry

Garnet Chemistry

	Weight percent oxide								Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0293gt2-2-16	36.681	0.04	21.118	30.487	7.131	2.44	1.558	99.455	2.9821	0.0024	2.0237	2.0729	0.4911	0.2957	0.1357	8.0036
TS0293-gt3-1-1	36.829	0.006	21.099	33.031	4.418	2.58	1.697	99.66	2.986	0.0004	2.0164	2.2398	0.3034	0.3119	0.1475	8.0054
TS0293-gt3-1-2	36.787	0.002	21.238	32.627	4.642	2.551	1.715	99.562	2.983	0.0001	2.0299	2.2127	0.3188	0.3083	0.149	8.0019
TS0293-gt3-1-3	36.883	0.07	21.186	32.557	4.869	2.577	1.79	99.932	2.9816	0.0042	2.0187	2.2012	0.3334	0.3105	0.155	8.0047
TS0293-gt3-1-4	36.848	0.059	21.213	32.077	5.189	2.639	1.682	99.707	2.9827	0.0036	2.0239	2.1715	0.3558	0.3185	0.1459	8.002
TS0293-gt3-1-5	36.846	0.007	21.224	32.001	5.49	2.473	1.61	99.651	2.9865	0.0004	2.0276	2.1692	0.3769	0.2988	0.1399	7.9994
TS0293-gt3-1-6	36.465	0.023	21.083	31.616	5.566	2.46	1.623	98.836	2.9807	0.0014	2.0314	2.1614	0.3854	0.2997	0.1422	8.0022
TS0293-gt3-1-7	36.2	0.008	20.936	31.562	5.77	2.54	1.603	98.619	2.971	0.0005	2.0253	2.1664	0.4011	0.3108	0.1409	8.0161
TS0293-gt3-1-8	36.426	0.022	21.052	31.598	5.917	2.547	1.651	99.213	2.9714	0.0013	2.0241	2.1556	0.4088	0.3097	0.1443	8.0152
TS0293-gt3-1-9	36.753	0	21.102	31.405	5.974	2.433	1.642	99.309	2.9895	0	2.0232	2.1364	0.4116	0.295	0.1431	7.9989
TS0293-gt3-1-10	36.618	0.001	21.142	31.199	6.212	2.432	1.761	99.365	2.9794	0.0001	2.0276	2.123	0.4282	0.295	0.1535	8.0069
TS0293gt3-2-1	36.716	0.025	21.036	31.646	5.74	2.576	1.586	99.325	2.9864	0.0015	2.0168	2.1528	0.3955	0.3123	0.1382	8.0035
TS0293gt3-2-2	36.845	0.036	20.985	31.363	5.931	2.437	1.58	99.177	2.999	0.0022	2.0134	2.135	0.409	0.2957	0.1378	7.9921
TS0293gt3-2-3	36.774	0.003	21.224	31.185	6.212	2.471	1.676	99.545	2.9837	0.0002	2.0298	2.1161	0.4269	0.2988	0.1457	8.0012
TS0293gt3-2-4	36.542	0.063	21.166	30.712	6.307	2.555	1.649	98.994	2.9789	0.0038	2.0338	2.0939	0.4355	0.3104	0.144	8.0003
TS0293gt3-2-5	36.602	0.017	21.155	30.868	6.589	2.53	1.688	99.449	2.9756	0.0011	2.0271	2.0987	0.4537	0.3066	0.147	8.0098
TS0293gt3-2-6	36.739	0.021	21.322	31.009	6.821	2.435	1.559	99.906	2.9744	0.0013	2.0347	2.0996	0.4678	0.2938	0.1352	8.0068
TS0293gt3-2-7	36.447	0.008	21.058	30.696	6.938	2.466	1.534	99.147	2.9751	0.0005	2.0261	2.0956	0.4797	0.3001	0.1342	8.0113
TS0293gt3-2-8	36.647	0.014	21.068	30.329	6.949	2.432	1.644	99.083	2.9875	0.0009	2.0244	2.0678	0.4799	0.2955	0.1436	7.9997
TS0293gt3-2-9	36.782	0.062	21.003	30.522	6.948	2.407	1.562	99.286	2.9931	0.0038	2.0145	2.0772	0.4789	0.292	0.1362	7.9957
TS0293gt3-2-10	36.53	0	20.932	30.058	7.072	2.328	1.602	98.522	2.9946	0	2.0225	2.0608	0.4911	0.2845	0.1407	7.9943
TS0293gt3-2-11	36.56	0.042	21.005	30.445	7.136	2.342	1.598	99.128	2.9839	0.0026	2.0207	2.0781	0.4933	0.2849	0.1398	8.0034
TS0293gt3-2-12	36.654	0.043	21.159	30.417	7.152	2.422	1.618	99.465	2.9795	0.0026	2.0273	2.0679	0.4925	0.2935	0.1409	8.0042
TS0383gt1-1-1	37.445	0.013	21.336	31.952	4.294	3.671	1.481	100.192	2.9946	0.0008	2.0112	2.137	0.2909	0.4377	0.1269	7.9992
TS0383gt1-1-2	37.275	0	21.694	31.566	4.134	3.836	1.391	99.896	2.9817	0	2.0454	2.1117	0.2801	0.4574	0.1192	7.9955
TS0383gt1-1-3	37.362	0.051	21.505	31.678	4.13	3.906	1.507	100.139	2.984	0.003	2.0244	2.1159	0.2794	0.4651	0.1289	8.0007
TS0383gt1-1-4	37.29	0.011	21.673	31.228	4.077	3.954	1.71	99.943	2.979	0.0007	2.0408	2.0864	0.2759	0.4709	0.1463	8
TS0383gt1-1-5	37.274	0.003	21.519	31.452	4.145	3.924	1.726	100.043	2.9797	0.0002	2.0276	2.1027	0.2807	0.4676	0.1478	8.0063
TS0383gt1-1-6	37.144	0	21.44	31.4	4.23	3.953	1.629	99.796	2.9779	0	2.026	2.1054	0.2873	0.4725	0.14	8.0091
TS0383gt1-1-7	37.175	0.031	21.441	31.735	4.199	3.886	1.447	99.914	2.979	0.0018	2.0252	2.1269	0.285	0.4642	0.1242	8.0063
TS0383gt1-1-8	37.164	0.029	21.308	31.378	4.188	3.923	1.546	99.536	2.9862	0.0017	2.0182	2.1087	0.285	0.4699	0.1331	8.0028
TS0383gt1-1-9	37.137	0.027	21.579	31.312	4.271	4.068	1.464	99.858	2.9728	0.0016	2.0361	2.0963	0.2896	0.4855	0.1255	8.0074
TS0383gt1-1-10	37.02	0.024	21.373	31.285	4.261	3.964	1.455	99.382	2.9794	0.0015	2.0274	2.1057	0.2905	0.4756	0.1254	8.0056
TS0383gt1-2-1	37.438	0	21.513	31.208	4.311	3.968	1.498	99.936	2.9914	0	2.0261	2.0854	0.2918	0.4726	0.1283	7.9956
TS0383gt1-2-2	37.202	0.005	21.471	31.158	4.374	3.989	1.395	99.594	2.9846	0.0003	2.0304	2.0905	0.2972	0.477	0.1199	8
TS0383gt1-2-3	37.266	0	21.674	30.953	4.533	3.909	1.579	99.914	2.9793	0	2.0424	2.0696	0.307	0.4659	0.1353	7.9996
TS0383gt1-2-4	36.95	0	21.706	30.759	4.564	3.969	1.577	99.525	2.9664	0	2.054	2.0652	0.3104	0.475	0.1357	8.0067
TS0383gt1-2-5	37.288	0.029	21.435	30.633	4.673	3.987	1.571	99.616	2.9886	0.0017	2.025	2.0534	0.3173	0.4764	0.1349	7.9973
TS0383gt1-2-6	37.314	0.073	21.53	30.757	4.541	3.996	1.429	99.64	2.9879	0.0044	2.0321	2.0598	0.308	0.477	0.1226	7.9919
TS0383gt1-2-7	37.032	0.025	21.438	30.886	4.786	4.066	1.563	99.796	2.97	0.0015	2.0266	2.0716	0.3251	0.4861	0.1343	8.0152
TS0383gt1-2-8	37.124	0.015	21.466	30.728	4.813	4.007	1.569	99.722	2.9768	0.0009	2.0289	2.0607	0.3269	0.4789	0.1348	8.0079
TS0383gt1-2-9	37.135	0.013	21.581	30.699	4.834	3.978	1.468	99.708	2.9764	0.0008	2.0388	2.0578	0.3282	0.4753	0.1261	8.0034
TS0383gt1-2-10	37.61	0	21.465	30.502	4.923	3.941	1.472	99.913	3.0028	0	2.02	2.0367	0.3329	0.469	0.1259	7.9873
TS0383gt1-2-11	36.985	0.01	21.583	30.579	4.873	4.005	1.564	99.599	2.9688	0.0006	2.0421	2.0528	0.3313	0.4792	0.1345	8.0093
TS0383gt1-2-12	36.972	0.034	21.447	30.172	4.87	4.006	1.688	99.189	2.9765	0.0021	2.0352	2.0315	0.3321	0.4808	0.1456	8.0038
TS0383gt1-2-13	37.198	0	21.634	30.999	4.985	4.011	1.663	100.49	2.9649	0	2.0325	2.0664	0.3366	0.4765	0.1421	8.019
TS0383gt1-2-14	36.994	0	21.418	30.243	4.826	3.888	1.556	98.925	2.9854	0	2.0373	2.0411	0.3299	0.4678	0.1346	7.9962
TS0383gt1-2-15	36.844	0.041	21.343	30.312	4.948	3.944	1.577	99.009	2.9754	0.0025	2.0315	2.0472	0.3385	0.4748	0.1364	8.0063
TS0383gt1-2-16	37.035	0.01	21.467	30.704	4.804	3.913	1.558	99.491	2.9769	0.0006	2.0338	2.0641	0.3271	0.4688	0.1342	8.0055
TS0383gt2-1-1	37.088	0.028	21.609	31.659	4.453	3.382	1.468	99.687	2.9812	0.0017	2.0474	2.1283	0.3032	0.4053	0.1264	7.9935
TS0383gt2-1-2	37.088	0.023	21.547	31.663	4.264	3.702	1.493	99.78	2.9766	0.0014	2.0384	2.1253	0.2899	0.4429	0.1284	8.0029
TS0383gt2-1-3	37.333	0.04	21.664	31.677	4.257	3.747	1.536	100.254	2.9795	0.0024	2.0379	2.1144	0.2878	0.4457	0.1313	7.999
TS0383gt2-1-4	37.251	0	21.617	31.507	4.222	3.905	1.46	99.962	2.9794	0	2.0379	2.1075	0.286	0.4656	0.1251	8.0015
TS0383gt2-1-5	37.33	0.011	21.552	31.393	4.126	3.87	1.502	99.784	2.9882	0.0007	2.0334	2.1016	0.2798	0.4618	0.1289	7.9945
TS0383gt2-1-6	37.416	0	21.543	31.469	4.233	3.905	1.424	99.99	2.9899	0	2.0291	2.103	0.2865	0.4651	0.1219	7.9955
TS0383gt2-1-7	37.346	0	21.319	31.418	4.263	4.058	1.466	99.87	2.9898	0	2.0118	2.1035	0.2891	0.4842	0.1258	8.0042
TS0383gt2-1-8	37.376	0	21.458	31.44	4.294	3.871	1.442	99.881	2.9913	0	2.0243	2.1044	0.2911	0.4618	0.1236	7.9966
TS0383gt2-1-9	37.424	0	21.646	31.388	4.198	4.007	1.578	100.241	2.9822	0	2.0331	2.0919	0.2833	0.476	0.1348	8.0013
TS0383gt2-1-10	37.228	0.075	21.508	31.177	4.32	3.935	1.547	99.79	2.9811	0.0045	2.0301	2.088	0.293	0.4697	0.1328	7.9993
TS0383gt2-2-1	37.241	0	21.424	31.129	4.206	4.148	1.458	99.606	2.9852	0	2.0242	2.0869	0.2856	0.4956	0.1252	8.0027
TS0383gt2-2-2	37.134	0	21.688	31.207	4.291	4.036	1.461	99.817	2.9721	0	2.046	2.089	0.2909	0.4815	0.1253	8.0048
TS0383gt2-2-3	37.238	0	21.729	31.269	4.238	3.952	1.467	99.893	2.9771	0	2.0477	2.0907	0.287	0.4709	0.1256	7.999
TS0383gt2-2-4	37.222	0	21.523	31.196	4.301	3.962	1.476	99.68	2.9833	0	2.0333	2.0911	0.292	0.4734	0.1268	7.9999
TS0383gt2-2-5	37.389	0.034	21.626	31.341	4.273	4.048	1.525	100.236	2.9799	0.002	2.0316	2.089	0.2885	0.4809	0.1302	8.0021
TS0383gt2-2-6	37.353	0	21.474	31.3	4.226	4.091	1.607	100.051	2.9833	0	2.0215	2.0907	0.2859	0.4871	0.1375	8.0061
TS0383gt2-2-7	37.283	0.056	21.493	31.18	4.288	3.98	1.723	100.003	2.9799	0.0034	2.0248	2.0842	0.2903	0.4742	0.1475	8.0043
TS0383gt2-2-8	37.141	0.023	21.425	31.165	4.225	3.968	1.698	99.645	2.9797	0.0014	2.0261	2.0911	0.2871	0.4746	0.146	8.006
TS2336b-gt1-1-1	36.911	0	21.458	33.786	3.921	3.221	0.703	100	2.9749	0	2.0384	2.2773	0.2677	0.3869	0.0607	8.0059
TS2336b-gt1-1-2	36.859	0	21.224	33.876	3.736	3.402	0.719	99.816	2.9769	0	2.0204	2.2882	0.2556	0.4095	0.0623	8.0129
TS2336b-gt1-1-3	36.871	0.007	21.311	33.815	3.647	3.478	0.744	99.873	2.9738	0.0004	2.026	2.2809	0.2491	0.4182	0.0643	8.0127
TS2336b-gt1-1-4	37.074	0.003	21.378	33.782	3.62	3.563	0.677	100.097	2.9797	0.0002	2.0253	2.2707	0.2464	0.4268	0.0583	8.0074
TS2336b-gt1-1-5	36.835	0.027	21.214	33.466	3.542	3.592	0.772	99.448	2.9788	0.0016	2.0221	2.2634	0.2427	0.433	0.0669	8.0085

Appendix 1 Mineral Chemistry

Garnet Chemistry

	Weight percent oxide								Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS2336b-gt1-1-6	36.763	0.004	21.207	33.736	3.501	3.587	0.738	99.536	2.9738	0.0003	2.022	2.2823	0.2399	0.4325	0.064	8.0148
TS2336b-gt1-1-7	36.941	0	21.354	33.478	3.428	3.667	0.723	99.591	2.9795	0	2.0301	2.2582	0.2342	0.4408	0.0625	8.0054
TS2336b-gt1-1-8	36.823	0	21.366	33.613	3.394	3.682	0.723	99.601	2.9722	0	2.0327	2.269	0.232	0.4431	0.0625	8.0115
TS2336b-gt1-1-9	36.853	0	21.269	33.51	3.447	3.737	0.719	99.535	2.9761	0	2.0245	2.2632	0.2358	0.4499	0.0622	8.0117
TS2336b-gt1-1-10	36.919	0	21.169	33.619	3.403	3.811	0.689	99.61	2.9797	0	2.0139	2.2692	0.2326	0.4585	0.0596	8.0135
TS2336b-gt1-2-1	36.208	0	21.074	33.347	3.274	3.701	0.776	98.38	2.9621	0	2.032	2.2815	0.2269	0.4514	0.068	8.0219
TS2336b-gt1-2-2	37.154	0.058	21.312	33.638	3.329	3.74	0.714	99.945	2.9849	0.0035	2.0181	2.2601	0.2265	0.4479	0.0615	8.0026
TS2336b-gt1-2-3	36.83	0	21.33	33.553	3.369	3.962	0.732	99.776	2.9666	0	2.0251	2.2603	0.2299	0.4757	0.0632	8.0208
TS2336b-gt1-2-4	36.766	0.005	21.318	33.504	3.303	3.947	0.735	99.578	2.9666	0.0003	2.0275	2.2609	0.2258	0.4748	0.0636	8.0195
TS2336b-gt1-2-5	36.89	0	21.28	33.116	3.343	3.963	0.706	99.318	2.9785	0	2.0252	2.2362	0.2286	0.4794	0.0611	8.009
TS2336b-gt1-2-6	37.018	0.003	21.287	33.385	3.224	3.992	0.69	99.599	2.9809	0.0002	2.0205	2.2484	0.2199	0.4792	0.0595	8.0086
TS2336b-gt1-2-7	37.231	0.001	21.251	32.895	3.366	4.012	0.767	99.523	2.9944	0.0001	2.0146	2.2127	0.2293	0.4811	0.0661	7.9984
TS2336b-gt1-2-8	36.688	0	21.493	33.4	3.216	4.05	0.741	99.588	2.9574	0	2.0421	2.2517	0.2196	0.4867	0.064	8.0215
TS2336b-gt1-2-9	37.115	0.057	21.424	33.197	3.341	3.988	0.742	99.864	2.9786	0.0034	2.0265	2.2281	0.2271	0.4771	0.0638	8.0047
TS2336b-gt1-2-10	37.019	0.015	21.344	33.207	3.343	4.075	0.76	99.763	2.9756	0.0009	2.0222	2.2323	0.2276	0.4883	0.0654	8.0124
TS2336b-gt1-2-11	37.066	0	21.323	32.992	3.322	4.062	0.791	99.556	2.9824	0	2.0222	2.2201	0.2264	0.4872	0.0682	8.0065
TS2336b-gt1-2-12	37.137	0	21.466	33.412	3.301	3.958	0.745	100.019	2.9776	0	2.0287	2.2405	0.2242	0.473	0.064	8.008
TS2336b-gt1-2-13	36.982	0	21.306	33.073	3.344	4.133	0.757	99.595	2.9764	0	2.0212	2.2262	0.228	0.4959	0.0653	8.0131
TS2336b-gt2-1-1	36.653	0.016	21.316	33.383	3.658	3.329	0.724	99.079	2.9764	0.001	2.0403	2.2672	0.2516	0.403	0.063	8.0025
TS2336b-gt2-1-2	36.782	0	21.321	33.591	3.713	3.392	0.72	99.519	2.9758	0	2.0332	2.2728	0.2545	0.4091	0.0624	8.0078
TS2336b-gt2-1-3	36.879	0.018	21.427	33.668	3.535	3.435	0.674	99.636	2.9768	0.0011	2.0386	2.2728	0.2417	0.4133	0.0583	8.0026
TS2336b-gt2-1-4	36.821	0.03	21.242	33.723	3.502	3.473	0.73	99.521	2.976	0.0019	2.025	2.281	0.2399	0.4187	0.0632	8.0077
TS2336b-gt2-1-5	37.187	0.007	21.494	33.779	3.535	3.653	0.723	100.378	2.9779	0.0004	2.0288	2.2623	0.2398	0.436	0.062	8.0072
TS2336b-gt2-1-6	36.781	0.039	21.477	33.6	3.468	3.613	0.775	99.753	2.9652	0.0024	2.0409	2.2655	0.2368	0.4342	0.0669	8.0119
TS2336b-gt2-1-7	36.555	0.003	21.438	33.983	3.454	3.594	0.691	99.718	2.9547	0.0002	2.0425	2.2972	0.2365	0.433	0.0599	8.024
TS2336b-gt2-1-8	36.738	0.049	21.407	33.713	3.3	3.707	0.706	99.62	2.9653	0.003	2.0366	2.2758	0.2256	0.446	0.0611	8.0134
TS2336b-gt2-1-9	36.641	0	21.309	33.766	3.445	3.759	0.704	99.624	2.9614	0	2.0301	2.2824	0.2359	0.4529	0.0609	8.0236
TS2336b-gt2-1-10	36.711	0.011	21.404	33.65	3.418	3.762	0.711	99.667	2.9627	0.0007	2.0361	2.2712	0.2336	0.4526	0.0615	8.0184
TS2336b-gt2-2-1	36.709	0	21.245	33.757	3.349	3.714	0.714	99.488	2.9694	0	2.0256	2.2837	0.2295	0.4478	0.0619	8.0179
TS2336b-gt2-2-2	36.624	0	21.228	33.666	3.289	3.644	0.684	99.135	2.9718	0	2.0303	2.2846	0.226	0.4408	0.0595	8.013
TS2336b-gt2-2-3	36.844	0.042	21.326	33.342	3.284	3.712	0.691	99.241	2.9794	0.0025	2.0327	2.2549	0.225	0.4475	0.0599	8.0019
TS2336b-gt2-2-4	36.557	0	21.426	33.861	3.385	3.741	0.743	99.713	2.953	0	2.0401	2.2875	0.2316	0.4504	0.0643	8.0269
TS2336b-gt3-1-1	36.857	0	21.415	33.45	3.65	3.494	0.707	99.573	2.9761	0	2.0382	2.2589	0.2496	0.4206	0.0612	8.0046
TS2336b-gt3-1-2	36.758	0	21.364	33.302	3.493	3.616	0.785	99.318	2.9737	0	2.0372	2.2532	0.2394	0.4361	0.0681	8.0077
TS2336b-gt3-1-3	36.789	0	21.498	33.854	3.452	3.616	0.696	99.905	2.9637	0	2.0413	2.2808	0.2356	0.4342	0.0601	8.0157
TS2336b-gt3-1-4	36.721	0	21.278	33.489	3.263	3.666	0.719	99.136	2.976	0	2.0326	2.2698	0.224	0.4429	0.0625	8.0078
TS2336b-gt3-1-5	36.734	0	21.175	33.605	3.372	3.796	0.726	99.408	2.9723	0	2.0196	2.2741	0.2311	0.4578	0.0629	8.0178
TS2336b-gt3-1-6	36.964	0	21.347	33.421	3.407	3.719	0.729	99.587	2.9803	0	2.0287	2.2536	0.2327	0.447	0.063	8.0053
TS2336b-gt3-1-7	37.2	0	21.391	33.567	3.307	3.681	0.716	99.862	2.989	0	2.0259	2.2556	0.2251	0.4408	0.0616	7.998
TS2336b-gt3-2-1	37.119	0	21.502	33.419	3.163	3.939	0.718	99.86	2.979	0	2.034	2.243	0.215	0.4713	0.0617	8.0041
TS2336b-gt3-2-2	36.9	0	21.372	33.581	3.213	3.923	0.693	99.682	2.9721	0	2.029	2.2621	0.2192	0.471	0.0598	8.0132
TS2336b-gt3-2-3	37.105	0.033	21.56	33.431	3.345	3.978	0.741	100.193	2.9705	0.002	2.0344	2.2383	0.2268	0.4747	0.0636	8.0103
TS2336b-gt3-2-4	37.007	0	21.396	33.405	3.27	3.896	0.7	99.674	2.9783	0	2.0296	2.2484	0.2229	0.4674	0.0604	8.007
TS2336b-gt3-2-5	37.115	0.028	21.306	33.329	3.205	3.909	0.693	99.585	2.9871	0.0017	2.0212	2.2434	0.2185	0.469	0.0597	8.0006
TS2336b-gt3-2-6	36.974	0.024	21.423	33.356	3.281	3.928	0.74	99.726	2.9741	0.0015	2.0311	2.2439	0.2235	0.471	0.0637	8.0088
TS2336b-gt3-2-7	36.876	0.028	21.504	33.33	3.241	3.994	0.754	99.727	2.966	0.0017	2.0386	2.242	0.2208	0.4789	0.065	8.0131
TS2336b-gt3-2-8	36.899	0	21.433	33.676	3.229	4.014	0.714	99.965	2.965	0	2.0299	2.2631	0.2198	0.4808	0.0615	8.0201
TS2336b-gt3-2-9	36.762	0.028	21.508	33.04	3.302	3.87	0.699	99.209	2.9699	0.0017	2.048	2.2323	0.2259	0.466	0.0605	8.0043
TS0032bgt2-1-1	36.893	0	20.757	31.936	5.747	2.669	0.972	98.974	3.01	0	1.9962	2.1791	0.3971	0.3245	0.085	7.992
TS0032bgt2-12-1	36.775	0	20.786	32.364	5.73	2.907	1.052	99.614	2.9882	0	1.9908	2.1994	0.3944	0.3522	0.0916	8.0166
TS0032bgt2-1-3	36.99	0	20.933	32.477	5.621	2.985	1.058	100.064	2.9892	0	1.9939	2.1949	0.3848	0.3595	0.0916	8.0139
TS0032bgt2-1-4	36.874	0	20.869	32.447	5.547	3.052	1.051	99.84	2.9867	0	1.9923	2.1979	0.3806	0.3685	0.0912	8.0173
TS0032bgt2-1-5	36.959	0	20.876	32.417	5.479	3.134	1.063	99.928	2.9887	0	1.9899	2.1924	0.3753	0.3778	0.0921	8.0162
TS0032bgt2-1-6	37.047	0	21.024	32.501	5.466	3.236	1.069	100.343	2.9827	0	1.9952	2.1884	0.3728	0.3884	0.0922	8.0197
TS0032bgt2-1-7	36.812	0	20.93	32.292	5.405	3.259	1.054	99.752	2.9807	0	1.9976	2.1868	0.3707	0.3933	0.0914	8.0205
TS0032bgt2-1-8	37.072	0	21.408	32.219	5.357	3.231	1.106	100.393	2.9761	0	2.0257	2.1632	0.3643	0.3866	0.0951	8.011
TS0032bgt2-1-9	36.875	0	21.148	32.276	5.349	3.275	1.143	100.066	2.9743	0	2.0107	2.1773	0.3655	0.3938	0.0987	8.0204
TS0032bgt2-1-10	36.97	0	21.217	32.309	5.205	3.353	1.2	100.254	2.9741	0	2.0119	2.1737	0.3547	0.4021	0.1035	8.0201
TS0032bgt2-2-1	37.007	0.067	21.106	32.041	5.158	3.389	1.102	99.87	2.9839	0.004	2.0059	2.1606	0.3523	0.4073	0.0952	8.0092
TS0032bgt2-2-21	37.095	0	20.884	32.096	5.228	3.292	1.133	99.728	2.9974	0	1.9891	2.169	0.3578	0.3965	0.0981	8.0079
TS0032bgt2-2-3	36.885	0.006	20.961	32.154	5.051	3.418	1.188	99.663	2.9831	0.0004	1.9982	2.1748	0.346	0.4121	0.1029	8.0175
TS0032bgt2-2-4	37.076	0	21.068	32.122	5.023	3.424	1.261	99.974	2.9865	0	2.0003	2.164	0.3427	0.4111	0.1088	8.0134
TS0032bgt2-2-5	37.014	0.041	21.082	31.828	4.983	3.484	1.308	99.74	2.9851	0.0025	2.004	2.1467	0.3404	0.4188	0.113	8.0105
TS0032bgt2-2-6	37.365	0.029	21.247	32.11	5.138	3.474	1.338	100.701	2.9861	0.0017	2.0014	2.1461	0.3478	0.4138	0.1145	8.0114
TS0032bgt2-2-7	37.252	0	21.124	31.899	5.017	3.489	1.436	100.217	2.9897	0	1.9983	2.1411	0.3411	0.4175	0.1235	8.0112
TS0032bgt2-2-8	37.103	0	21.189	31.779	5.138	3.472	1.513	100.194	2.9802	0	2.0061	2.1348	0.3496	0.4158	0.1302	8.0167
TS0032bgt2-2-9	37.091	0.003	21.205	31.923	4.916	3.473	1.582	100.193	2.9789	0.0002	2.0074	2.1442	0.3345	0.4158	0.1362	8.0173
TS0032bgt2-2-10	37.277	0	21.265	31.853	5.036	3.535	1.551	100.517	2.9824	0	2.0054	2.1313	0.3413	0.4216	0.133	8.015
TS0032bgt2-3-1	36.933	0	20.928	31.243	5.026	3.559	1.389	99.078	2.9936	0	1.9994	2.1179	0.345	0.43	0.1206	8.0065
TS0032bgt2-3-2	36.769	0.01	21.178	31.218	5.087	3.52	1.322	99.104	2.9797	0.0006	2.0229	2.1158	0.3492	0.4252	0.1148	8.0082
TS0032bgt2-3-3	36.805	0	21.123	31.316	5.167	3.558	1.329	99.298	2.9791	0	2.0153	2.1199	0.3543	0.4293	0.1153	8.0132
TS0032bgt2-3-4	30.87	0	22.076	28.587	4.897	2.814	1.286	90.53	2.7563	0	2.3233	2.1347	0.3704	0.3745	0.123	8.0822

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS0032bgt2-3-5	36.681	0	21.051	30.724	5.277	3.499	1.412	98.644	2.9847	0	2.019	2.0908	0.3637	0.4244	0.1231	8.0057
TS0032bgt2-3-6	37.423	0.019	21.314	31.699	5.298	3.588	1.237	100.578	2.9892	0.0012	2.0067	2.1176	0.3585	0.4273	0.1059	8.0065
TS0032bgt2-3-7	36.998	0	21.091	31.335	5.381	3.516	1.352	99.673	2.9849	0	2.0057	2.1143	0.3677	0.4228	0.1168	8.0122
TS0032bgt2-3-8	36.994	0	20.849	31.526	5.355	3.515	1.289	99.528	2.992	0	1.9876	2.1324	0.3668	0.4237	0.1117	8.0142
TS0032bgt2-4-1	37.206	0.047	20.84	31.291	5.309	3.358	1.444	99.495	3.0056	0.0029	1.9843	2.1141	0.3633	0.4043	0.125	7.9996
TS0032bgt2-4-2	37.081	0	21.037	31.897	5.324	3.473	1.336	100.148	2.9834	0	1.995	2.1463	0.3629	0.4165	0.1152	8.0194
TS2133gt1-1-1	37.156	0	21.223	32.497	1.441	4.929	1.269	98.515	2.9936	0	2.0155	2.1897	0.0983	0.592	0.1095	7.9987
TS2133gt1-1-2	37.477	0	21.414	32.416	1.397	5.172	1.283	99.159	2.9943	0	2.0166	2.166	0.0946	0.616	0.1098	7.9973
TS2133gt1-1-3	37.253	0	21.282	32.345	1.375	5.281	1.233	98.769	2.9893	0	2.0129	2.1707	0.0934	0.6317	0.106	8.0041
TS2133gt1-1-4	37.568	0	21.514	32.343	1.305	5.348	1.288	99.366	2.9918	0	2.0195	2.1541	0.088	0.6349	0.1099	7.9983
TS2133gt1-1-5	37.619	0	21.495	32.372	1.292	5.422	1.262	99.462	2.9926	0	2.0155	2.1538	0.0871	0.643	0.1076	7.9997
TS2133gt1-2-1	37.572	0	21.462	32.764	1.215	5.771	1.737	100.521	2.9665	0	1.9974	2.1635	0.0813	0.6793	0.147	8.035
TS2133gt1-2-2	37.062	0	21.252	32.154	1.174	5.921	1.69	99.253	2.9606	0	2.001	2.1482	0.0795	0.705	0.1447	8.039
TS2133gt1-2-3	37.363	0	21.462	32.155	1.19	5.867	1.702	99.739	2.9665	0	2.0085	2.1351	0.08	0.6944	0.1448	8.0293
TS2133gt1-2-4	37.083	0	21.282	32.15	1.131	6.018	1.722	99.386	2.9576	0	2.0007	2.1446	0.0764	0.7155	0.1472	8.042
TS2133gt1-2-5	37.26	0	21.191	32.155	1.142	5.998	1.75	99.496	2.9677	0	1.9895	2.1419	0.077	0.7121	0.1494	8.0376
TS2133gt1-2-6	37.575	0	21.289	32.11	1.229	5.996	1.678	99.877	2.9778	0	1.9886	2.1282	0.0825	0.7083	0.1425	8.028
TS2133gt1-2-7	37.755	0	21.386	31.948	1.218	5.928	1.733	99.968	2.9853	0	1.9932	2.1126	0.0816	0.6988	0.1468	8.0183
TS2133gt1-2-8	37.578	0	21.523	31.857	1.142	6.003	1.784	99.887	2.9729	0	2.0071	2.1078	0.0765	0.7079	0.1513	8.0236
TS2133gt1-2-9	37.823	0	21.438	31.881	1.192	6.033	1.75	100.117	2.9843	0	1.9937	2.1037	0.0797	0.7096	0.148	8.019
TS2133gt1-2-10	37.944	0	21.51	31.723	1.149	6.1	1.73	100.156	2.9883	0	1.9968	2.0895	0.0767	0.7162	0.146	8.0135
TS2133gt1-3-1	37.898	0	21.135	32.04	1.12	6.239	1.816	100.248	2.9889	0	1.9647	2.1133	0.0748	0.7335	0.1535	8.0287
TS2133gt1-3-2	37.858	0	20.698	31.582	1.144	6.195	1.869	99.346	3.01	0	1.9397	2.1	0.0771	0.7342	0.1592	8.0202
TS2133gt1-3-3	37.957	0	20.844	31.432	1.204	6.31	1.838	99.585	3.0075	0	1.9466	2.0829	0.0808	0.7453	0.1561	8.0192
TS2133gt1-3-4	37.781	0	20.905	31.437	1.185	6.312	1.754	99.374	3.0003	0	1.9568	2.0879	0.0797	0.7472	0.1493	8.0212
TS2133gt1-3-5	38.031	0	20.887	31.284	1.185	6.336	1.882	99.605	3.01	0	1.9485	2.0707	0.0794	0.7475	0.1596	8.0157
TS2133gt1-3-6	37.556	0	21.503	31.253	1.214	6.151	1.791	99.468	2.977	0	2.0091	2.0718	0.0815	0.7269	0.1522	8.0185
TS2133gt1-3-7	37.716	0.011	21.842	31.561	1.251	6.162	1.79	100.333	2.9654	0.0007	2.0242	2.0753	0.0833	0.7222	0.1508	8.0219
TS2133gt1-3-8	37.854	0	21.631	31.466	1.298	6.151	1.896	100.296	2.9773	0	2.0054	2.0698	0.0865	0.7212	0.1598	8.02
TS2133gt1-3-9	37.411	0	21.441	31.388	1.29	6.241	1.826	99.597	2.9665	0	2.004	2.0816	0.0866	0.7377	0.1552	8.0316
TS2133gt1-3-10	37.641	0	21.465	31.507	1.317	6.225	1.923	100.078	2.9709	0	1.997	2.0798	0.088	0.7324	0.1627	8.0308
TS2133gt1-4-1	38.019	0.016	21.47	31.352	1.596	5.892	2.006	100.351	2.9911	0.0009	1.991	2.0629	0.1063	0.691	0.1691	8.0124
TS2133gt1-4-2	37.849	0	21.167	31.555	1.668	5.789	1.963	99.991	2.9948	0	1.9741	2.0881	0.1118	0.6829	0.1664	8.0181
TS2133gt1-4-3	37.779	0	21.237	31.441	1.765	5.691	1.918	99.831	2.9937	0	1.9836	2.0837	0.1184	0.6723	0.1629	8.0146
TS2133gt1-4-4	37.596	0	21.193	31.436	1.795	5.508	2.042	99.57	2.9903	0	1.9869	2.0911	0.1209	0.6531	0.1741	8.0164
TS2133gt1-14-5	37.812	0	21.031	31.692	1.867	5.528	1.897	99.827	3.0016	0	1.9678	2.104	0.1255	0.6542	0.1614	8.0146
TS2133gt1-4-6	37.813	0.007	21.426	31.732	1.874	5.308	1.775	99.935	2.9959	0.0004	2.0009	2.1026	0.1258	0.6269	0.1507	8.0032
TS2133gt1-4-7	37.749	0.01	21.47	31.596	1.991	5.194	1.734	99.744	2.9962	0.0006	2.0087	2.0974	0.1338	0.6146	0.1475	7.9988
TS2133gt1-4-8	37.735	0.054	21.155	31.722	2.052	5.111	1.785	99.614	3.0037	0.0032	1.9849	2.1118	0.1383	0.6065	0.1523	8.0007
TS2133gt1-4-10	37.566	0.065	21.093	31.767	2.09	5.06	1.864	99.505	2.9973	0.0039	1.9837	2.1197	0.1413	0.6018	0.1594	8.0071
TS2133gt1-4-12	37.409	0.044	21.252	30.987	1.978	5.205	1.978	98.853	2.9942	0.0026	2.0049	2.0742	0.1341	0.621	0.1697	8.0007
TS2133gt1-4-13	37.879	0.087	21.359	31.574	2.008	5.239	1.981	100.127	2.9965	0.0052	1.9916	2.0889	0.1346	0.6178	0.1679	8.0026
TS2133gt1-4-14	37.801	0.048	21.404	31.404	2.104	5.177	1.979	99.917	2.9961	0.0028	1.9996	2.0817	0.1413	0.6117	0.1681	8.0013
TS2133gt1-4-15	37.58	0.007	21.388	31.218	2.153	5.2	2.137	99.683	2.9873	0.0004	2.004	2.0754	0.145	0.6162	0.182	8.0103
TS2133gt1-4-15	37.671	0.081	21.244	31.437	2.192	5.178	2.158	99.961	2.9897	0.0049	1.9872	2.0866	0.1474	0.6126	0.1835	8.0119
TS2133gt1-4-16	37.692	0	21.255	31.914	2.563	5.088	2.08	100.592	2.9828	0	1.9826	2.1122	0.1718	0.6002	0.1764	8.026
TS2133gt1-5-1	37.304	0	21.429	31.673	2.515	5.039	2.03	99.99	2.9685	0	2.0099	2.1079	0.1695	0.5977	0.1731	8.0266
TS2133gt1-5-2	37.618	0	21.169	31.524	2.609	5.068	2.112	100.1	2.9884	0	1.9822	2.0944	0.1756	0.6002	0.1797	8.0205
TS2133gt1-5-3	37.557	0	21.243	31.605	2.627	5.004	1.983	100.019	2.9864	0	1.991	2.1017	0.177	0.5932	0.1689	8.0182
TS2133gt1-5-4	37.528	0	21.326	31.434	2.558	5.134	2.023	100.003	2.9816	0	1.9972	2.0886	0.1722	0.6081	0.1722	8.0199
TS2133gt1-5-5	37.761	0	21.069	31.384	2.416	5.228	2.014	99.872	3.0005	0	1.9733	2.0856	0.1626	0.6193	0.1715	8.0128
TS2133gt1-5-6	37.48	0	20.826	31.17	2.401	5.289	1.906	99.072	3.0022	0	1.9663	2.0881	0.1629	0.6316	0.1636	8.0147
TS2133gt1-5-7	37.592	0	21.217	31.682	2.238	5.534	1.833	100.096	2.9815	0	1.9834	2.1015	0.1504	0.6543	0.1557	8.0268
TS2133gt1-5-8	37.448	0	21.245	31.412	2.277	5.432	1.884	99.698	2.9805	0	1.993	2.0909	0.1535	0.6445	0.1606	8.023
TS4085gt2-1-1	36.935	0	20.598	32.585	5.43	2.571	1.093	99.212	3.0122	0	1.98	2.2225	0.3751	0.3125	0.0955	7.9979
TS4085gt2-1-2	36.507	0	20.816	32.826	5.227	2.553	1.123	99.052	2.9862	0	2.0069	2.2455	0.3621	0.3112	0.0984	8.0103
TS4085gt2-1-3	36.889	0	20.95	32.962	5.071	2.696	1.103	99.671	2.9934	0	2.0038	2.237	0.3486	0.3261	0.0959	8.0048
TS4085gt2-1-4	36.943	0	21.044	33.172	4.959	2.697	1.168	99.983	2.9891	0	2.007	2.2447	0.3399	0.3254	0.1013	8.0074
TS4085gt2-1-5	37.07	0	21.082	33.127	4.772	2.871	1.226	100.148	2.9904	0	2.0046	2.2349	0.3261	0.3453	0.106	8.0073
TS4085gt2-1-6	36.852	0	21.12	32.913	4.681	2.928	1.206	99.7	2.9841	0	2.0158	2.2289	0.3211	0.3535	0.1047	8.0082
TS4085gt2-1-7	36.439	0.022	20.867	32.502	4.925	2.868	1.288	98.911	2.9784	0.0014	2.0103	2.2217	0.341	0.3495	0.1128	8.0151
TS4085gt2-1-8	36.717	0	20.919	32.829	4.899	2.924	1.237	99.525	2.9829	0	2.0031	2.2305	0.3371	0.3541	0.1077	8.0154
TS4085gt2-1-9	36.854	0.047	21.036	32.712	4.718	2.965	1.221	99.553	2.9871	0.0029	2.0097	2.2174	0.3239	0.3582	0.106	8.0052
TS4085gt2-1-10	36.814	0.043	20.894	33.165	4.761	3.01	1.304	99.991	2.9791	0.0026	1.993	2.2446	0.3263	0.3632	0.1131	8.0219
TS4085gt2-2-1	36.973	0	20.872	32.956	4.755	3.028	1.16	99.744	2.9939	0	1.9921	2.2318	0.3261	0.3655	0.1006	8.01
TS4085gt2-2-2	36.811	0.009	20.945	32.415	4.731	3.034	1.187	99.132	2.9932	0.0006	2.0074	2.2043	0.3259	0.3677	0.1034	8.0025
TS4085gt2-2-3	36.924	0.02	20.98	32.566	4.76	3.045	1.296	99.611	2.9901	0.0012	2.0026	2.2069	0.3265	0.3676	0.1124	8.0073
TS4085gt2-2-4	36.85	0	20.869	32.552	4.735	3.08	1.273	99.359	2.9921	0	1.9973	2.2105	0.3257	0.3728	0.1108	8.0092
TS4085gt2-2-5	36.934	0.007	20.854	32.549	4.677	3.067	1.274	99.362	2.9973	0.0004	1.9948	2.2091	0.3215	0.371	0.1108	8.0049
TS4085gt2-2-6	36.881	0	21.045	32.54	4.748	3.16	1.241	99.615	2.9854	0	2.0079	2.2029	0.3255	0.3813	0.1077	8.0107
TS4085gt2-2-7	36.947	0	20.697	32.352	4.71	3.1	1.186	98.992	3.0074	0	1.9857	2.2024	0.3248	0.3761	0.1034	7.9999
TS4085gt2-2-8	36.908	0	20.772	32.528	4.761	3.137	1.167	99.273	2.9985	0	1.9891	2.2101	0.3277	0.3799	0.1016	8.0069

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS4085gt2-2-9	36.893	0.001	20.762	32.673	4.72	3.153	1.154	99.356	2.9963	0.0001	1.9876	2.2193	0.3247	0.3817	0.1004	8.0101
TS4085gt2-2-10	36.725	0	20.732	32.51	4.644	3.095	1.158	98.864	2.9963	0	1.9937	2.2183	0.321	0.3764	0.1012	8.0069
TS4085gt2-3-1	36.831	0	20.694	32.51	4.698	3.146	1.067	98.946	3.0015	0	1.9877	2.2157	0.3243	0.3822	0.0932	8.0046
TS4085gt2-3-2	36.475	0.02	20.948	32.39	4.381	3.057	1.084	98.355	2.987	0.0012	2.022	2.2183	0.3039	0.3732	0.0951	8.0008
TS1026gt1-1-1	36.911	0.081	21.127	32.023	5.178	2.208	1.039	98.567	3.0158	0.005	2.0347	2.1882	0.3584	0.2689	0.091	7.962
TS1026gt1-1-2	36.716	0	21.053	32.49	5.035	2.469	0.936	98.699	3.0018	0	2.0288	2.2215	0.3487	0.3009	0.082	7.9838
TS1026gt1-1-3	37.05	0.034	21.237	32.794	4.832	2.55	0.988	99.485	3.0024	0.0021	2.0285	2.2226	0.3317	0.3081	0.0858	7.9812
TS1026gt1-1-4	36.841	0	21.132	32.723	4.794	2.701	1.016	99.207	2.9955	0	2.0252	2.2252	0.3302	0.3274	0.0886	7.9921
TS1026gt1-1-5	36.883	0	20.796	33.507	4.902	2.761	0.874	99.723	2.9953	0	1.9906	2.2758	0.3372	0.3343	0.0761	8.0093
TS1026gt1-1-6	36.997	0	20.57	33.723	4.792	2.841	0.953	99.876	3.0022	0	1.9675	2.2886	0.3293	0.3437	0.0828	8.0141
TS1026gt1-1-7	36.987	0.017	20.69	33.57	4.794	2.845	0.916	99.819	3.0002	0.001	1.9781	2.2773	0.3294	0.344	0.0796	8.0096
TS1026gt1-1-8	37.207	0	20.83	33.599	4.735	2.92	0.994	100.285	3.0012	0	1.9804	2.2666	0.3235	0.3511	0.0859	8.0087
TS1026gt1-1-9	37.232	0.053	20.69	33.58	4.669	2.962	0.937	100.123	3.007	0.0032	1.9696	2.2681	0.3194	0.3566	0.0811	8.005
TS1026gt1-1-10	37.082	0	21.279	33.436	4.738	2.965	0.912	100.412	2.9833	0	2.0178	2.2497	0.3229	0.3555	0.0786	8.0078
TS1026gt1-2-1	37.164	0.008	21.269	33.278	4.652	3.026	0.865	100.262	2.9899	0.0005	2.017	2.2391	0.317	0.363	0.0746	8.0012
TS1026gt1-2-2	37.222	0	21.133	33.415	4.584	3.147	0.905	100.406	2.9918	0	2.0021	2.2462	0.3121	0.3771	0.078	8.0073
TS1026gt1-2-3	37.106	0.001	21.255	33.409	4.43	3.122	0.903	100.226	2.9862	0.0001	2.0162	2.2487	0.382	0.3746	0.0779	8.0057
TS1026gt1-2-4	37.166	0	21.068	33.267	4.564	3.168	0.968	100.201	2.9926	0	1.9996	2.2402	0.3113	0.3803	0.0836	8.0076
TS1026gt1-2-5	37.087	0.004	21.257	33.266	4.491	2.973	0.944	100.022	2.9903	0.0002	2.0202	2.2432	0.3067	0.3573	0.0816	7.9996
TS1026gt1-2-6	37.223	0	21.372	33.524	4.519	3.046	0.982	100.666	2.984	0	2.0195	2.2476	0.3068	0.364	0.0844	8.0063
TS1026gt1-2-7	37.193	0.012	21.336	33.491	4.485	3.009	0.919	100.445	2.9873	0.0007	2.0199	2.2496	0.3051	0.3603	0.0791	8.0021
TS1026gt1-2-8	37.282	0	21.336	33.558	4.418	3.068	0.904	100.566	2.9898	0	2.0168	2.2507	0.3001	0.3667	0.0776	8.0017
TS1026gt1-2-9	37.196	0.042	21.311	33.69	4.564	3.088	0.915	100.806	2.9804	0.0026	2.0128	2.2577	0.3098	0.3688	0.0785	8.0106
TS1026gt1-2-10	37.004	0.003	21.128	33.187	4.182	3.077	0.948	99.529	2.9949	0.0002	2.0155	2.2464	0.2867	0.3712	0.0822	7.9971
TS1026gt1-3-1	36.715	0.031	21.099	33.413	4.13	3.046	0.952	99.386	2.9812	0.0019	2.0194	2.269	0.2841	0.3687	0.0829	8.0072
TS1026gt1-3-2	36.87	0.048	21.202	33.466	4.247	2.982	0.931	99.746	2.9828	0.0029	2.0218	2.2644	0.291	0.3597	0.0807	8.0034
TS1181gt1-1-1	37.011	0	20.554	30.085	6.417	0.862	4.627	99.556	3.0171	0	1.975	2.0511	0.4431	0.1048	0.4042	7.9953
TS1181gt1-1-2	36.771	0.006	20.478	30.801	5.871	1.003	4.708	99.638	3.0011	0.0003	1.97	2.1024	0.4059	0.122	0.4118	8.0135
TS1181gt1-1-3	36.882	0.006	20.559	30.958	5.4	1.067	4.601	99.473	3.0085	0.0004	1.9767	2.112	0.3731	0.1298	0.4021	8.0026
TS1181gt1-1-4	36.753	0	20.241	31.344	5.062	1.157	4.672	99.229	3.0099	0	1.9539	2.1468	0.3512	0.1413	0.41	8.0131
TS1181gt1-1-5	36.721	0	20.59	31.345	5.004	1.23	4.714	99.604	2.9939	0	1.9787	2.1373	0.3456	0.1494	0.4119	8.0168
TS1181gt1-1-6	37.122	0	20.533	31.545	4.709	1.346	4.891	100.146	3.0065	0	1.9601	2.1367	0.3231	0.1625	0.4245	8.0134
TS1181gt1-1-7	37.129	0	20.575	31.847	4.634	1.407	4.912	100.504	2.9992	0	1.959	2.1515	0.3174	0.1695	0.4251	8.0215
TS1181gt1-1-8	37.116	0	20.542	31.923	4.47	1.364	4.824	100.239	3.0046	0	1.9601	2.1612	0.3065	0.1645	0.4184	8.0154
TS1181gt1-1-9	36.949	0	20.479	31.662	4.501	1.402	4.895	99.888	3.0013	0	1.9607	2.1509	0.3097	0.1698	0.4261	8.0185
TS1181gt1-1-10	36.849	0	20.555	31.743	4.378	1.416	4.926	99.867	2.9942	0	1.9686	2.1571	0.3013	0.1715	0.4288	8.0216
TS1181gt1-2-1	36.726	0.036	20.579	31.884	4.629	1.381	4.822	100.057	2.9838	0.0022	1.9706	2.1664	0.3186	0.1673	0.4198	8.0287
TS1181gt1-2-2	36.732	0	20.564	31.815	4.668	1.359	4.757	99.895	2.9882	0	1.9719	2.1646	0.3217	0.1648	0.4146	8.0258
TS1181gt1-2-3	36.823	0	20.649	31.955	4.606	1.343	4.44	99.816	2.995	0	1.9796	2.1736	0.3173	0.1628	0.3869	8.0152
TS1181gt1-2-4	36.596	0	20.691	32.032	4.871	1.422	4.251	99.863	2.9801	0	1.986	2.1815	0.336	0.1726	0.371	8.0273
TS1181gt1-2-5	35.577	0	20.342	31.866	4.824	1.279	4.134	98.022	2.9608	0	1.9954	2.2179	0.3401	0.1587	0.3686	8.0415
TS1181gt1-2-6	37.159	0	20.389	31.89	4.924	1.362	4.225	99.949	3.0177	0	1.9517	2.1659	0.3387	0.1649	0.3676	8.0065
TS1181gt1-2-7	36.919	0.006	20.407	31.677	4.992	1.361	4.178	99.54	3.0106	0.0004	1.9615	2.1603	0.3448	0.1654	0.3651	8.0082
TS1181gt1-2-8	36.645	0.035	20.369	31.605	4.986	1.345	4.227	99.212	3.0007	0.0022	1.966	2.1644	0.3459	0.1641	0.3709	8.0142
TS1181gt1-2-9	36.566	0	20.6	31.706	5.08	1.313	4.144	99.409	2.9896	0	1.9852	2.168	0.3518	0.16	0.3631	8.0177
TS1181gt1-2-10	36.551	0	20.439	31.414	4.953	1.313	4.247	98.917	2.9998	0	1.9772	2.1562	0.3444	0.1606	0.3735	8.0117
TS1181gt1-3-1	36.528	0	20.219	31.675	4.772	1.381	4.284	98.859	3.0026	0	1.959	2.1775	0.3322	0.1693	0.3773	8.0179
TS1181gt1-3-2	36.609	0	20.29	31.256	4.058	1.654	4.758	98.625	3.0042	0	1.9626	2.1451	0.2821	0.2023	0.4184	8.0147
TS1181gt1-3-3	36.77	0	20.752	31.725	3.788	1.673	5.066	99.774	2.9835	0	1.9847	2.1528	0.2604	0.2024	0.4405	8.0243
TS1181gt1-3-4	34.333	0	19.291	31.41	3.283	2.309	4.2	94.826	2.9477	0	1.9523	2.2554	0.2388	0.2956	0.3864	8.0762
TS1181gt1-3-5	36.918	0	20.566	32.073	4.115	1.611	4.926	100.209	2.9896	0	1.963	2.1722	0.2823	0.1945	0.4274	8.029
TS1181gt1-3-6	37.059	0.135	20.533	32.074	5.621	1.208	4.198	100.828	2.9944	0.0082	1.9556	2.1675	0.3847	0.1455	0.3634	8.0194
TS1181gt1-3-7	36.748	0.114	20.135	31.916	5.762	1.137	4.093	99.905	3.0014	0.007	1.9384	2.1801	0.3987	0.1384	0.3582	8.0222
TS1181gt1-3-8	36.903	0.059	20.502	32.216	4.545	1.439	4.632	100.296	2.9912	0.0036	1.9588	2.1839	0.3121	0.1738	0.4023	8.0257
TS1107gt1-1-1	37.058	0.019	21.182	33.825	3.742	3.748	0.882	100.456	2.9728	0.0012	2.0029	2.2694	0.2543	0.4482	0.0758	8.0246
TS1107gt1-1-2	37.006	0.01	21.151	33.891	3.667	3.665	0.844	100.234	2.9756	0.0006	2.0046	2.2791	0.2498	0.4393	0.0727	8.0217
TS1107gt1-1-3	36.659	0	21.101	33.022	3.701	3.706	0.819	99.008	2.9768	0	2.0196	2.2426	0.2546	0.4486	0.0713	8.0135
TS1107gt1-1-4	37.257	0	21.038	33.526	3.598	3.702	0.8	99.921	2.9971	0	1.9948	2.2555	0.2452	0.4439	0.069	8.0055
TS1107gt1-1-5	37.102	0	21.141	33.439	3.637	3.734	0.885	99.938	2.9853	0	2.0049	2.2501	0.2479	0.4478	0.0763	8.0123
TS1107gt1-1-6	37.229	0	21.06	33.658	3.603	3.822	0.86	100.232	2.988	0	1.9924	2.2593	0.245	0.4573	0.074	8.016
TS1107gt1-1-7	37.169	0	20.938	33.466	3.661	3.698	0.865	99.797	2.9958	0	1.9891	2.2558	0.2499	0.4443	0.0747	8.0097
TS1107gt1-1-8	36.93	0	21.129	33.564	3.667	3.652	0.889	99.831	2.9784	0	2.0086	2.2639	0.2505	0.4391	0.0768	8.0173
TS1107gt1-1-9	37.537	0	21.347	33.851	3.59	3.729	0.921	100.975	2.9887	0	2.0034	2.2541	0.2421	0.4426	0.0786	8.0095
TS1107gt1-1-10	37.288	0	21.073	33.845	3.56	3.743	0.882	100.391	2.9894	0	1.9913	2.2693	0.2417	0.4474	0.0758	8.0149
TS1107gt1-2-1	37.528	0	21.152	33.858	3.586	3.765	0.888	100.777	2.9948	0	1.9896	2.2597	0.2424	0.4479	0.076	8.0105
TS1107gt1-2-2	37.46	0	21.053	33.872	3.631	3.672	0.887	100.575	2.9974	0	1.9856	2.2667	0.2461	0.438	0.076	8.0098
TS1107gt1-2-3	36.976	0	21.03	33.604	3.516	3.729	0.903	99.758	2.9831	0	1.9998	2.2673	0.2402	0.4485	0.0781	8.017
TS1107gt1-2-4	37.56	0	20.975	34.049	3.487	3.737	0.854	100.662	3.0024	0	1.9763	2.2762	0.2361	0.4453	0.0732	8.0096
TS1107gt1-2-5	37.166	0	20.959	33.831	3.614	3.839	0.894	100.303	2.9847	0	1.984	2.2722	0.2458	0.4596	0.077	8.0233
TS1107gt1-2-6	37.17	0.013	21.034	33.914	3.434	3.707	0.903	100.175	2.9872	0.0008	1.9925	2.2795	0.2338	0.4441	0.0778	8.0157
TS1107gt1-2-7	37.705	0.006	20.812	33.879	3.544	3.811	0.9	100.657	3.0125	0.0003	1.9599	2.2637	0.2399	0.4539	0.077	8.0072
TS1107gt1-2-8	36.856	0	21.246	33.15	3.708	3.678	0.886	99.524	2.9768	0	2.0227	2.2392	0.2537	0.4428	0.0767	8.012

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS1107gt1-2-9	37.397	0	21.192	33.371	3.616	3.725	0.886	100.187	2.997	0	2.0018	2.2366	0.2455	0.445	0.0761	8.002
TS1107gt1-2-10	37.305	0	21.094	33.516	3.572	3.807	0.901	100.195	2.9923	0	1.9944	2.2484	0.2427	0.4552	0.0775	8.0105
TS1107gt1-2-11	37.251	0	21.151	33.352	3.73	3.72	0.895	100.099	2.9909	0	2.0017	2.2396	0.2537	0.4452	0.077	8.0081
TS1107gt1-2-12	37.027	0	21.194	33.313	3.578	3.778	0.89	99.78	2.982	0	2.0119	2.2438	0.2441	0.4536	0.0768	8.0122
TS1107gt1-2-13	36.833	0	21.13	33.498	3.657	3.624	0.837	99.579	2.9777	0	2.0134	2.2648	0.2505	0.4367	0.0725	8.0156
TS1107gt1-2-14	37.319	0	20.787	33.783	3.557	3.669	0.823	99.938	3.0054	0	1.9732	2.2753	0.2426	0.4404	0.071	8.0079
TS1107gt1-2-15	37.421	0	21.068	33.681	3.564	3.591	0.864	100.189	3.0026	0	1.9925	2.2601	0.2422	0.4296	0.0743	8.0013
TS1107gt1-2-16	37.377	0	21.12	33.818	3.602	3.668	0.815	100.4	2.9948	0	1.9946	2.2661	0.2445	0.4381	0.07	8.0082
TS1107gt1-2-17	37.223	0.01	21.082	33.805	3.556	3.704	0.835	100.215	2.9891	0.0006	1.9955	2.2703	0.2419	0.4433	0.0719	8.0126
TS1107gt1-2-18	36.79	0	20.833	33.422	3.617	3.582	0.847	99.091	2.9895	0	1.9954	2.2713	0.249	0.4339	0.0737	8.0128
TS1047gt1-1-1	37.008	0.008	20.872	34.36	3.336	3.212	0.965	99.761	2.9943	0.0005	1.9905	2.325	0.2286	0.3874	0.0837	8.01
TS1047gt1-1-2	37.063	0	20.729	34.527	3.258	3.228	0.957	99.762	3.0001	0	1.9778	2.3373	0.2234	0.3896	0.083	8.0112
TS1047gt1-1-3	37.258	0	20.738	34.6	3.208	3.291	0.99	100.085	3.0046	0	1.9712	2.3336	0.2192	0.3957	0.0856	8.0099
TS1047gt1-1-4	36.9	0	20.85	34.443	3.12	3.296	0.954	99.563	2.9909	0	1.992	2.3348	0.2142	0.3983	0.0828	8.013
TS1047gt1-1-5	36.821	0	20.764	34.146	3.105	3.458	0.966	99.26	2.9909	0	1.988	2.3196	0.2136	0.4188	0.0841	8.015
TS1047gt1-1-6	37.02	0.015	20.887	34.587	3.06	3.604	0.996	100.169	2.9825	0.0009	1.9835	2.3304	0.2088	0.4328	0.086	8.025
TS1047gt1-1-7	37.282	0	21.038	34.503	3.055	3.695	0.975	100.548	2.9874	0	1.987	2.3122	0.2074	0.4413	0.0837	8.019
TS1047gt1-1-8	37.34	0	20.886	34.552	2.902	3.706	1.014	100.4	2.9957	0	1.9751	2.3183	0.1972	0.4432	0.0872	8.0167
TS1047gt1-1-9	37.267	0	21.136	34.571	2.844	3.693	0.957	100.468	2.9862	0	1.9963	2.3168	0.193	0.4412	0.0822	8.0157
TS1047gt1-1-10	36.839	0.009	20.898	33.92	2.794	3.602	0.931	98.993	2.9921	0.0006	2.0007	2.3041	0.1922	0.4361	0.081	8.0068
TS1047gt1-2-1	37.357	0	20.777	34.422	2.79	3.651	0.947	99.944	3.0074	0	1.9716	2.3176	0.1903	0.4382	0.0817	8.0069
TS1047gt1-2-2	37.364	0	21.03	34.192	2.65	3.711	0.894	99.841	3.0043	0	1.9932	2.2993	0.1805	0.4448	0.077	7.9991
TS1047gt1-2-3	37.423	0	20.827	34.065	2.639	3.784	0.888	99.626	3.0143	0	1.9772	2.2946	0.1801	0.4543	0.0766	7.9971
TS1047gt1-2-4	37.413	0	20.758	34.134	2.642	3.876	0.878	99.701	3.0125	0	1.9702	2.2987	0.1802	0.4652	0.0757	8.0026
TS1047gt1-2-5	36.751	0	20.284	33.989	2.559	3.964	0.973	98.52	3.0019	0	1.9529	2.3219	0.177	0.4827	0.0851	8.0215
TS1047gt1-2-6	37.318	0	20.46	34.3	2.504	4.007	0.933	99.522	3.0138	0	1.9476	2.3167	0.1713	0.4824	0.0808	8.0126
TS1047gt1-2-7	37.314	0	20.55	34.213	2.531	3.975	0.909	99.492	3.0129	0	1.9558	2.3104	0.1731	0.4784	0.0786	8.0092
TS1047gt1-2-8	37.33	0.001	20.371	34.296	2.571	4.019	0.898	99.486	3.0167	0.0001	1.9404	2.3179	0.176	0.4842	0.0777	8.013
TS1047gt1-2-9	37.039	0	20.729	34.269	2.501	4.107	0.912	99.557	2.9909	0	1.973	2.3143	0.1711	0.4944	0.0789	8.0226
TS1047gt1-2-10	37.096	0	20.769	33.686	2.6	4.066	0.853	99.07	3.0024	0	1.9814	2.2802	0.1782	0.4906	0.074	8.0068
TS1047gt1-3-1	37.397	0	20.731	33.627	2.572	4.059	0.853	99.239	3.0176	0	1.9718	2.2693	0.1758	0.4882	0.0737	7.9964
TS1047gt1-3-2	36.894	0	20.411	33.864	2.501	4.108	0.957	98.735	3.0022	0	1.9578	2.3046	0.1724	0.4984	0.0835	8.0189
TS1047gt1-3-3	37.225	0	20.765	33.982	2.624	3.974	0.914	99.484	3.0039	0	1.975	2.2934	0.1793	0.478	0.079	8.0086
TS1047gt1-3-4	37.27	0	20.614	33.888	2.633	3.976	0.93	99.311	3.0121	0	1.9637	2.2905	0.1802	0.479	0.0806	8.0061
TS1047gt2-1-1	36.609	0	21.004	33.822	3.386	3.433	1.052	99.306	2.9733	0	2.0107	2.2973	0.233	0.4156	0.0916	8.0215
TS1047gt2-1-2	36.744	0	20.908	34.052	3.189	3.468	1.014	99.375	2.9815	0	1.9997	2.3108	0.2192	0.4194	0.0881	8.0187
TS1047gt2-1-3	36.923	0	20.71	33.976	3.331	3.423	1.04	99.403	2.9954	0	1.9804	2.3052	0.2289	0.414	0.0904	8.0143
TS1047gt2-1-4	36.919	0	20.79	34.298	3.187	3.535	1.001	99.73	2.9869	0	1.9826	2.3207	0.2184	0.4264	0.0868	8.0218
TS1047gt2-1-5	37.091	0	20.628	34.061	3.194	3.536	0.992	99.502	3.0037	0	1.969	2.3069	0.2191	0.4269	0.0861	8.0117
TS1047gt2-1-6	36.718	0.015	20.943	34.033	3.098	3.448	0.923	99.178	2.9831	0.0009	2.0056	2.3124	0.2132	0.4176	0.0803	8.0131
TS1047gt2-1-7	36.846	0.011	20.876	34.472	3.067	3.564	1.006	99.842	2.9787	0.0007	1.9893	2.3307	0.21	0.4295	0.0872	8.0261
TS1047gt2-1-8	37.016	0	21.077	34.377	2.973	3.545	0.938	99.926	2.984	0	2.0028	2.3177	0.203	0.426	0.081	8.0145
TS1047gt2-1-9	36.887	0	21.142	34.349	2.872	3.647	0.922	99.819	2.976	0	2.0105	2.3177	0.1962	0.4386	0.0797	8.0188
TS1047gt2-1-10	37.114	0	21.053	34.429	2.989	3.676	0.965	100.226	2.9833	0	1.9946	2.3144	0.2035	0.4404	0.0831	8.0193
TS1047gt2-2-1	36.586	0	21.141	34.107	2.86	3.608	0.912	99.214	2.9694	0	2.0225	2.3151	0.1966	0.4366	0.0793	8.0195
TS1047gt2-2-2	36.871	0	21.148	34.296	2.811	3.667	0.952	99.745	2.9759	0	2.0118	2.3149	0.1922	0.4411	0.0823	8.0182
TS1047gt2-2-3	37.005	0	21.151	34.166	2.803	3.587	0.92	99.632	2.9865	0	2.0121	2.3061	0.1916	0.4315	0.0796	8.0074
TS1047gt2-2-4	36.938	0	21.07	34.323	2.755	3.757	0.951	99.794	2.9791	0	2.003	2.3151	0.1882	0.4517	0.0822	8.0194
TS1047gt2-2-5	36.906	0	21.048	34.066	2.716	3.787	0.898	99.421	2.9838	0	2.0058	2.3034	0.186	0.4564	0.0778	8.0132
TS1047gt2-2-6	36.846	0	21.052	33.993	2.742	3.931	0.999	99.563	2.9755	0	2.0039	2.2959	0.1876	0.4732	0.0864	8.0225
TS1047gt2-2-7	37.194	0.029	20.995	34.47	2.622	4.044	0.92	100.274	2.9832	0.0017	1.9848	2.3122	0.1781	0.4835	0.0791	8.0226
TS1047gt2-2-8	37.032	0	21.1	34.232	2.604	4.114	0.945	100.027	2.9755	0	1.9983	2.3003	0.1772	0.4928	0.0813	8.0254
TS1047gt2-2-9	37.105	0	21.133	34.387	2.555	4.096	0.908	100.184	2.9768	0	1.9984	2.3073	0.1736	0.4898	0.078	8.0239
TS1047gt2-2-10	37.181	0	20.996	34.207	2.606	4.065	0.95	100.005	2.9869	0	1.9881	2.2982	0.1773	0.4868	0.0817	8.019
TS1047gt2-2-11	36.89	0	21.142	34.064	2.544	4.002	0.97	99.612	2.9748	0	2.0096	2.2974	0.1738	0.481	0.0838	8.0204
TS1047gt2-3-1	37.274	0	21.234	34.239	2.469	4.095	0.939	100.25	2.9834	0	2.0032	2.2919	0.1674	0.4886	0.0805	8.015
TS1047gt2-3-2	37.361	0	21.169	34.216	2.491	4.087	1.014	100.338	2.9878	0	1.9954	2.2885	0.1688	0.4872	0.0869	8.0146
TS1047gt2-3-3	37.221	0	21.078	34.191	2.488	4.076	0.978	100.032	2.987	0	1.9937	2.2947	0.1691	0.4876	0.0841	8.0162
TS1047gt2-3-4	37.224	0	21.021	34.168	2.528	4.049	1.08	100.07	2.9874	0	1.9885	2.2933	0.1719	0.4844	0.0929	8.0184
TS1047gt2-3-5	37.083	0	20.943	33.904	2.556	4.069	1.015	99.57	2.9892	0	1.9899	2.2856	0.1745	0.4889	0.0877	8.0159
TS1047gt2-3-6	37.198	0	20.904	34.365	2.539	4.029	1.034	100.069	2.9886	0	1.9796	2.3091	0.1728	0.4825	0.089	8.0216
TS1181gt2-1-1	36.832	0.017	20.402	32.611	4.816	1.283	3.913	99.874	3.0022	0.001	1.9601	2.2231	0.3325	0.1559	0.3418	8.0166
TS1181gt2-1-2	36.662	0.033	20.284	32.685	4.68	1.257	4.047	99.648	2.998	0.002	1.9551	2.2353	0.3242	0.1533	0.3546	8.0225
TS1181gt2-1-3	36.719	0.014	20.212	32.623	4.71	1.379	3.904	99.561	3.0035	0.0009	1.9487	2.2317	0.3263	0.1682	0.3421	8.0214
TS1181gt2-1-4	36.444	0	20.265	32.598	4.571	1.358	3.982	99.218	2.9925	0	1.9613	2.2385	0.318	0.1662	0.3503	8.0268
TS1181gt2-1-5	36.628	0	20.372	32.892	4.679	1.371	4.012	99.954	2.9882	0	1.959	2.2442	0.3233	0.1668	0.3507	8.0322
TS1181gt2-1-6	36.683	0	20.382	32.992	4.751	1.339	3.928	100.075	2.99	0	1.9582	2.249	0.328	0.1626	0.343	8.0308
TS1181gt2-1-7	37.028	0.01	20.472	33.345	4.686	1.371	3.875	100.787	2.9958	0.0006	1.9523	2.2563	0.3211	0.1654	0.3359	8.0274
TS1181gt2-1-8	36.67	0.022	20.278	33.068	4.587	1.43	3.919	99.974	2.9915	0.0014	1.9498	2.2561	0.317	0.1739	0.3426	8.0323
TS1181gt2-1-9	36.793	0.021	20.039	33.16	4.567	1.433	3.838	99.851	3.0056	0.0013	1.9295	2.2654	0.316	0.1745	0.3359	8.0282
TS1181gt2-1-10	36.546	0	19.874	33.189	4.544	1.439	3.875	99.467	3.0011	0	1.9236	2.2793	0.3161	0.1761	0.3409	8.0371
TS1181gt2-2-1	36.496	0	20.105	33.405	4.384	1.517	3.881	99.788	2.9872	0	1.9397	2.2867	0.3039	0.1851	0.3403	8.0429

Appendix 1 Mineral Chemistry

Garnet Chemistry

Weight percent oxide									Cation percentage							
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Total
TS1181gt2-2-2	36.8	0.004	20.011	33.377	4.368	1.55	3.988	100.098	3.0003	0.0002	1.9231	2.2759	0.3016	0.1884	0.3484	8.0379
TS1181gt2-2-3	36.429	0	20.02	32.729	4.207	1.529	4.112	99.026	2.9968	0	1.9412	2.2517	0.2931	0.1874	0.3624	8.0326
TS1181gt2-2-4	37.06	0	20.594	33.143	4.184	1.584	4.165	100.73	2.9924	0	1.96	2.2381	0.2861	0.1907	0.3603	8.0276
TS1181gt2-2-5	36.959	0.028	20.234	32.715	4.124	1.557	4.319	99.936	3.006	0.0017	1.9399	2.2254	0.2842	0.1888	0.3764	8.0224
TS1181gt2-2-6	36.865	0.038	20.614	32.878	3.986	1.607	4.485	100.473	2.9828	0.0023	1.966	2.2248	0.2732	0.1939	0.3888	8.0318
TS1181gt2-2-7	36.996	0	20.44	32.695	3.945	1.591	4.596	100.263	2.9974	0	1.952	2.2154	0.2708	0.1922	0.399	8.0268
TS1181gt2-2-8	36.478	0	19.851	31.954	3.903	1.607	4.606	98.399	3.0103	0	1.9309	2.2053	0.2728	0.1977	0.4073	8.0244
TS1181gt2-2-9	37.052	0.064	20.251	32.126	3.832	1.584	5.179	100.088	3.0036	0.0039	1.935	2.178	0.2632	0.1914	0.4498	8.0249
TS1181gt2-2-10	36.84	0.062	20.36	31.777	3.617	1.626	5.333	99.615	2.9961	0.0038	1.9518	2.1614	0.2492	0.1971	0.4648	8.0242
TS1181gt2-3-1	36.919	0.106	20.31	31.573	3.782	1.574	5.462	99.726	2.9992	0.0065	1.9448	2.1451	0.2602	0.1906	0.4754	8.0218
TS1181gt2-3-2	36.959	0.043	20.202	31.907	3.727	1.567	4.953	99.358	3.0133	0.0026	1.9414	2.1756	0.2574	0.1905	0.4327	8.0135
TS1181gt2-3-3	35.994	0	19.757	32.355	4.219	1.498	4.375	98.198	2.9897	0	1.9342	2.2476	0.2968	0.1855	0.3894	8.0432
TS1181gt2-3-4	36.648	0	19.669	32.431	4.157	1.493	4.493	98.891	3.0172	0	1.9087	2.233	0.2899	0.1833	0.3964	8.0285
TS1181gt2-3-5	36.823	0	19.72	32.878	4.362	1.514	4.236	99.533	3.0162	0	1.904	2.2523	0.3026	0.1849	0.3718	8.0318
TS1181gt2-3-6	36.665	0	19.834	33.076	4.449	1.446	3.991	99.461	3.0082	0	1.9181	2.2696	0.3092	0.1769	0.3509	8.0329

Appendix 1 Mineral Chemistry

Biotite Data

Weight Percent Oxide

Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Cl	F	Total
396-gt2-bt1-1	36.973	2.063	18.116	17.284	0.121	12.081	0.066	0.25	8.451	0.121	0	0.168	95.623
396-gt2-bt1-2	37.163	1.997	18.212	17.168	0.135	12.116	0.07	0.231	8.732	0.116	0.015	0.141	96.034
396-gt2-bt2-1	37.708	1.791	18.2	17.089	0.174	12.397	0.066	0.233	8.679	0.086	0.01	0.143	96.514
396-gt2-bt2-2	37.546	1.912	17.85	16.707	0.117	11.658	0.166	0.206	8.493	0.127	0.034	0.174	94.909
396-gt2-bt3-1	37.375	2.146	18.263	17.562	0.13	12.307	0.071	0.23	8.663	0.095	0	0.115	96.909
396-gt1-bt1-1	36.878	1.898	18.628	17.348	0.142	12.276	0.012	0.207	8.992	0.105	0	0.17	96.584
396-gt1-bt1-2	37.426	1.966	18.785	16.612	0.118	11.805	0.127	0.251	8.342	0.098	0.024	0.188	95.658
396-gt1-bt1-3	36.786	1.946	18.337	17.279	0.113	12.01	0.108	0.264	8.708	0.117	0.021	0.144	95.767
396-gt1-bt2-1	36.9	2.033	18.426	17.377	0.143	12.186	0.092	0.216	8.454	0.141	0.036	0.236	96.133
396-gt1-bt2-2	37.206	2.036	18.304	17.543	0.155	12.264	0.07	0.241	8.888	0.157	0	0.149	96.95
396-gt1-bt2-3	36.704	2.045	18.343	17.434	0.157	12.355	0.067	0.224	8.876	0.159	0.015	0.121	96.446
396-gt1-bt2-4	36.903	2.054	18.53	17.243	0.144	12.215	0.05	0.222	9.094	0.152	0.014	0.183	96.724
396-gt1-bt3-1	36.186	1.611	18.64	17.167	0.112	11.675	0.173	0.183	7.886	0.165	0.049	0.255	93.984
396-gt1-bt3-2	37.105	1.84	18.465	17.095	0.109	12.417	0.054	0.228	9.084	0.152	0.017	0.201	96.678
396-gt1-bt3-3	36.887	1.898	18.39	17.064	0.154	12.606	0.041	0.216	8.864	0.19	0.003	0.137	96.391
388-gt7-bt1-1	35.867	1.568	19.833	19.258	0.062	10.609	0.022	0.229	9.136	0.104	0.018	0.151	96.789
388-gt7-bt1-2	35.765	1.569	19.815	19.215	0.062	10.669	0.012	0.218	8.988	0.077	0	0.189	96.499
388-gt7-bt1-3	35.368	1.779	19.712	18.952	0.077	10.674	0	0.244	9.332	0.124	0.021	0.19	96.388
388-gt7-bt2-1	35.773	1.808	19.474	19.086	0.049	10.62	0.035	0.22	9.091	0.071	0.013	0.17	96.335
388-gt7-bt2-2	35.909	1.716	19.588	19.273	0.074	10.632	0.008	0.224	8.863	0.115	0	0.096	96.458
388-gt7-bt2-3	35.497	1.598	19.521	19.133	0.087	10.755	0.001	0.102	9.169	0.122	0.001	0.153	96.075
388-gt7-bt3-1	35.955	1.631	19.589	19.231	0.053	10.497	0.022	0.227	8.972	0.095	0.018	0.184	96.393
388-gt7-bt3-2	35.856	1.731	19.733	19.321	0.07	10.697	0	0.214	8.97	0.062	0	0.12	96.723
388-gt7-bt3-3	35.818	1.761	19.497	19.151	0.053	10.56	0.009	0.204	9.358	0.101	0	0.149	96.598
388-gt7-bt3-4	35.778	1.75	19.571	19.321	0.065	10.571	0	0.164	8.949	0.092	0.004	0.086	96.314
388-gt7-bt4-1	35.7	1.779	19.651	19.154	0.059	10.509	0.023	0.183	9.192	0.124	0	0.173	96.474
388-gt7-bt4-2	36.092	1.456	19.626	18.819	0.081	10.675	0.009	0.194	9.102	0.088	0	0.136	96.221
388-gt7-bt4-3	35.717	1.668	19.944	19.031	0.062	10.517	0	0.243	9.239	0.104	0.004	0.141	96.61
388-gt7-bt4-4	35.781	1.503	19.77	18.635	0.083	10.487	0.047	0.212	9.199	0.07	0	0.074	95.83
613-gt6-bt1-1	36.001	1.261	19.401	18.412	0.048	11.631	0.025	0.199	8.749	0.151	0	0.183	95.984
613-gt6-bt1-2	36.578	1.456	19.582	17.843	0.048	11.532	0.046	0.262	9.414	0.149	0	0.141	96.992
613-gt6-bt1-3	36.48	1.327	19.513	17.971	0.055	11.713	0.014	0.338	8.927	0.129	0.011	0.145	96.56
613-gt6-bt1-4	36.169	1.311	19.197	18.346	0.081	11.832	0	0.368	8.69	0.126	0	0.189	96.229
613-gt6-bt2-1	35.914	1.506	19.237	18.337	0.088	11.396	0.046	0.187	9.13	0.173	0.01	0.123	96.093
613-gt6-bt2-2	36.354	1.387	19.364	18.007	0.08	11.604	0.009	0.227	9.379	0.154	0	0.165	96.661
613-gt6-bt2-3	35.46	1.568	19.185	18.514	0.114	11.297	0.082	0.301	8.889	0.087	0.007	0.145	95.586
613-gt6-bt2-4	36.093	1.725	19.308	18.475	0.089	11.438	0.008	0.337	8.908	0.044	0	0.202	96.542
613-gt6-bt3-1	35.822	1.677	19.229	18.756	0.107	11.492	0.051	0.185	9.013	0.126	0.018	0.203	96.59
613-gt6-bt3-2	36.484	1.72	19.317	18.368	0.083	11.515	0.037	0.333	8.933	0.131	0	0.226	97.052
613-gt6-bt3-3	35.682	1.63	18.945	18.801	0.079	11.253	0.051	0.216	9.267	0.124	0.017	0.172	96.161
613-gt6-bt4-1	36.203	1.701	19.366	18.367	0.059	11.607	0.021	0.295	9.018	0.108	0.007	0.252	96.896
613-gt6-bt4-2	36.03	1.688	19.458	18.242	0.08	11.39	0.032	0.291	9.069	0.137	0.013	0.159	96.519
613-gt6-bt4-3	35.933	1.766	19.364	18.23	0.081	11.283	0.035	0.344	8.85	0.119	0	0.159	96.097
397-gt2-bt1-1	36.409	1.982	17.192	18.504	0.202	12.189	0.029	0.262	8.883	0.191	0	0.117	95.911

Cation proportions

Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Cr	Cl	F	Total
5.495	0.2306	3.1736	2.1483	0.0152	2.6766	0.0105	0.0722	1.6023	0.0143	0	0.0791	15.5177
5.504	0.2225	3.1792	2.1265	0.017	2.675	0.0111	0.0664	1.65	0.0136	0.0039	0.0662	15.5354
5.5448	0.198	3.1546	2.1016	0.0217	2.7175	0.0104	0.0665	1.6282	0.01	0.0025	0.0665	15.5223
5.5989	0.2144	3.1375	2.0836	0.0148	2.5914	0.0265	0.0596	1.6158	0.015	0.0085	0.0822	15.4483
5.4922	0.2372	3.1633	2.1583	0.0162	2.6959	0.0112	0.0656	1.624	0.011	0	0.0533	15.5282
5.442	0.2106	3.2402	2.141	0.0177	2.7005	0.0019	0.0591	1.6929	0.0122	0	0.0792	15.5973
5.5237	0.2182	3.2679	2.0504	0.0148	2.5972	0.0201	0.0719	1.5707	0.0114	0.006	0.0876	15.4399
5.4709	0.2177	3.2145	2.1492	0.0143	2.6625	0.0171	0.076	1.6523	0.0138	0.0053	0.0678	15.5614
5.4508	0.2259	3.2083	2.1468	0.018	2.6833	0.0145	0.0619	1.5933	0.0165	0.0091	0.1101	15.5385
5.4731	0.2253	3.1737	2.1581	0.0193	2.6892	0.0111	0.0687	1.6679	0.0183	0	0.0694	15.5742
5.4342	0.2277	3.201	2.1587	0.0197	2.7269	0.0106	0.0644	1.6766	0.0186	0.0039	0.0567	15.599
5.4393	0.2276	3.2192	2.1255	0.018	2.6838	0.0079	0.0635	1.71	0.0178	0.0035	0.0853	15.6014
5.4495	0.1825	3.3088	2.1621	0.0143	2.6211	0.0279	0.0535	1.5152	0.0196	0.0125	0.1212	15.4882
5.4624	0.2038	3.2041	2.1047	0.0136	2.725	0.0084	0.0651	1.7061	0.0177	0.0042	0.0934	15.6085
5.4498	0.2109	3.2025	2.1085	0.0192	2.7764	0.0065	0.0619	1.6709	0.0221	0.0007	0.064	15.5934
5.3375	0.1755	3.4787	2.3967	0.0078	2.3535	0.0035	0.066	1.7346	0.0123	0.0046	0.0712	15.6419
5.3309	0.1758	3.4812	2.3953	0.0078	2.3706	0.0019	0.0629	1.7092	0.0091	0	0.0893	15.6341
5.2908	0.2001	3.4757	2.3711	0.0097	2.3804	0	0.0707	1.7811	0.0147	0.0053	0.0901	15.6897
5.3456	0.2032	3.43	2.3852	0.0062	2.3658	0.0055	0.0639	1.7331	0.0084	0.0032	0.0804	15.6305
5.3601	0.1926	3.4464	2.4061	0.0094	2.3658	0.0013	0.0647	1.6878	0.0136	0	0.0456	15.5934
5.327	0.1804	3.453	2.4014	0.011	2.406	0.0001	0.0297	1.7556	0.0145	0.0004	0.0724	15.6515
5.3639	0.183	3.4446	2.3994	0.0067	2.3345	0.0036	0.0658	1.7076	0.0112	0.0046	0.087	15.6119
5.339	0.1939	3.4632	2.406	0.0089	2.3742	0	0.0617	1.7041	0.0073	0	0.0563	15.6146
5.3486	0.1978	3.4317	2.3916	0.0067	2.3507	0.0014	0.0591	1.7828	0.0119	0	0.0704	15.6527
5.3539	0.1969	3.452	2.4181	0.0083	2.358	0	0.0477	1.7085	0.0108	0.0011	0.0407	15.5961
5.3315	0.1998	3.4591	2.3922	0.0075	2.3395	0.0036	0.0531	1.7514	0.0147	0	0.0817	15.6341
5.3893	0.1636	3.4543	2.3501	0.0102	2.3762	0.0014	0.056	1.734	0.0104	0	0.0644	15.61
5.3253	0.187	3.5049	2.3731	0.0078	2.3374	0	0.0703	1.7573	0.0122	0.0011	0.0666	15.6431
5.3729	0.1697	3.4992	2.3403	0.0106	2.3476	0.0075	0.0618	1.7623	0.0083	0	0.0354	15.6156
5.3683	0.1415	3.41	2.2961	0.006	2.5854	0.004	0.0576	1.6645	0.0178	0	0.0862	15.6375
5.3989	0.1616	3.4068	2.2026	0.006	2.5373	0.0072	0.0749	1.7727	0.0174	0	0.0658	15.6512
5.3987	0.1477	3.4037	2.2242	0.0069	2.584	0.0022	0.0969	1.6855	0.0151	0.0028	0.0677	15.6355
5.3783	0.1466	3.3647	2.2815	0.0103	2.6228	0	0.106	1.6486	0.0148	0	0.089	15.6627
5.3687	0.1693	3.3895	2.2926	0.0111	2.5395	0.0074	0.0542	1.7413	0.0204	0.0025	0.0582	15.6547
5.3904	0.1546	3.3843	2.233	0.0101	2.5648	0.0014	0.0652	1.7742	0.018	0	0.0774	15.6734
5.3344	0.1774	3.4019	2.3293	0.0145	2.5334	0.0133	0.0878	1.7061	0.0103	0.0018	0.0688	15.679
5.3577	0.1926	3.3783	2.2936	0.0111	2.531	0.0013	0.0971	1.687	0.0052	0	0.0951	15.65
5.3294	0.1876	3.372	2.3336	0.0135	2.5487	0.0082	0.0534	1.7107	0.0148	0.0046	0.0954	15.6719
5.3784	0.1907	3.3564	2.2646	0.0103	2.5304	0.0058	0.0951	1.68	0.0152	0	0.1056	15.6325
5.3485	0.1837	3.3471	2.3569	0.01	2.5144	0.0082	0.0626	1.7722	0.0147	0.0042	0.0817	15.7042
5.3484	0.189	3.3723	2.2693	0.0073	2.5563	0.0033	0.0844	1.6997	0.0127	0.0017	0.1177	15.6621
5.3525	0.1886	3.4072	2.2664	0.01	2.5224	0.0052	0.0837	1.7188	0.0161	0.0032	0.0745	15.6486
5.3576	0.1981	3.4032	2.2732	0.0102	2.5077	0.0057	0.0994	1.6834	0.014	0	0.0747	15.6272
5.4653	0.2237	3.0419	2.323	0.0257	2.7276	0.0047	0.0763	1.7012	0.0227	0	0.0553	15.6674

Appendix 1 Mineral Chemistry

Biotite Data

Weight Percent Oxide

Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Cl	F	Total
397-gt2-bt1-2	36.071	1.822	17.301	19.26	0.238	12.938	0.029	0.225	7.937	0.192	0.001	0.116	96.081
397-gt2-bt1-3	36.329	1.777	17.367	18.659	0.168	12.373	0.005	0.304	8.574	0.181	0	0.129	95.812
397-gt2-bt2-1	36.423	1.72	17.361	18.403	0.178	12.425	0.033	0.219	8.981	0.169	0	0.109	95.975
397-gt2-bt2-2	36.861	1.903	17.49	18.546	0.193	12.215	0.036	0.285	8.896	0.147	0.018	0.129	96.663
397-gt2-bt2-3	36.342	1.809	17.32	18.712	0.186	12.253	0	0.2	8.717	0.134	0	0.102	95.732
397-gt2-bt3-1	36.84	1.724	17.499	18.285	0.182	12.214	0.024	0.227	8.946	0.115	0.004	0.157	96.15
397-gt2-bt3-2	36.53	1.814	17.418	18.722	0.197	12.272	0.028	0.241	8.918	0.166	0.027	0.173	96.427
397-gt2-bt3-3	36.338	1.833	17.222	19	0.185	12.187	0.02	0.179	9.098	0.196	0.014	0.198	96.384
287-gt1-bt1-1	24.533	0.076	23.77	22.713	0.432	16.325	0.015	0.02	0.027	0.019	0	0	87.93
287-gt1-bt1-2	24.531	0.1	23.393	22.421	0.429	16.432	0	0.019	0.043	0.221	0	0.02	87.601
287-gt1-bt1-3	24.246	0.105	23.737	22.72	0.383	16.326	0.029	0	0.015	0	0.009	0	87.568
287-gt1-bt2-1	24.408	0.054	23.684	22.273	0.353	16.294	0	0.016	0.042	0.085	0	0	87.209
287-gt1-bt2-2	24.349	0.081	23.451	23.046	0.406	16.058	0.054	0.019	0.038	0.076	0.009	0	87.585
287-gt1-bt2-3	24.424	0.045	23.708	22.482	0.421	16.471	0.021	0	0.024	0.092	0.001	0	87.689
287-gt1-bt3-1	24.364	0.074	24.012	22.917	0.397	16.224	0.008	0	0.03	0	0	0	88.026
287-gt1-bt3-2	24.502	0.084	23.552	22.978	0.408	16.261	0.005	0	0.035	0.159	0	0.016	87.993
287-gt1-bt4-1	24.38	0.052	24.053	22.955	0.425	16.29	0.004	0	0.028	0.051	0	0	88.238
287-gt1-bt4-2	24.159	0.055	23.6	22.701	0.422	16.252	0.011	0.01	0.035	0.029	0.034	0	87.3
287-gt1-bt4-3	24.485	0.064	23.927	22.595	0.411	16.352	0.01	0	0.057	0.012	0	0.04	87.936
0174-gt2-bt1-1	35.922	1.832	18.748	18.684	0.157	11.19	0.05	0.146	8.908	0.044	0	0.154	95.77
0174-gt2-bt1-2	35.76	1.737	18.976	18.528	0.128	11.183	0.016	0.167	9.088	0.067	0	0.169	95.748
0174-gt2-bt1-3	36.255	1.807	19.08	18.317	0.094	11.066	0	0.151	9.058	0.062	0	0.126	95.963
0174-gt2-bt2-1	35.97	1.85	18.859	18.366	0.14	11.148	0.001	0.198	9.191	0.073	0	0.218	95.922
0174-gt2-bt2-2	35.956	2.171	18.552	18.412	0.117	10.852	0.034	0.13	9.229	0.127	0	0.226	95.711
0174-gt2-bt2-3	35.347	1.872	18.629	18.652	0.135	11.146	0.087	0.164	8.773	0.052	0	0.168	94.954
0174-gt2-bt3-1	35.959	1.993	18.661	18.59	0.155	11.125	0.022	0.142	9.101	0.068	0.025	0.215	95.959
0174-gt2-bt3-2	35.333	1.768	18.27	20.082	0.104	11.2	0.068	0.102	8.323	0.051	0.007	0.144	95.389
0174-gt2-bt3-3	35.826	2.081	18.708	18.466	0.133	11.141	0.031	0.156	9.026	0.096	0.006	0.12	95.738
0174-gt1-bt1-1	36.17	1.644	18.891	18.301	0.143	11.086	0.024	0.125	9.357	0.037	0	0.198	95.893
0174-gt1-bt1-2	36.169	1.695	18.964	18.55	0.145	11.228	0.037	0.16	9.193	0.023	0	0.134	96.242
0174-gt1-bt1-3	36.021	1.702	18.971	18.265	0.092	11.141	0.022	0.174	9.234	0.056	0.012	0.14	95.768
0174-gt1-bt2-1	35.888	1.61	18.929	18.492	0.126	11.075	0.041	0.154	9.245	0.051	0	0.129	95.686
0174-gt1-bt2-2	36.024	1.606	18.892	18.44	0.112	11.008	0.07	0.195	9.113	0.038	0.006	0.166	95.599
0174-gt1-bt2-3	35.689	1.6	18.671	18.311	0.129	11.08	0.024	0.168	9.063	0.05	0	0.15	94.872
0174-gt1-bt3-1	35.993	1.708	18.913	18.561	0.132	11.068	0.099	0.194	8.879	0.063	0.021	0.202	95.743
0174-gt1-bt3-2	35.34	1.851	18.61	19.042	0.146	11.206	0.04	0.137	8.491	0.046	0.006	0.163	95.008
0174-gt1-bt3-3	35.789	1.98	18.878	18.374	0.124	11.009	0.041	0.15	8.994	0.061	0.01	0.151	95.495
0174-gt3-bt1-1	35.973	1.736	19.035	18.676	0.126	10.924	0.029	0.198	9.235	0.081	0	0.217	96.139
0174-gt3-bt1-2	34.001	1.631	18.418	22.107	0.099	10.975	0.097	0.121	7.844	0.051	0.01	0.221	95.48
0174-gt3-bt1-3	35.777	2.051	18.925	18.818	0.17	10.877	0.035	0.146	8.811	0.083	0	0.161	95.786
0174-gt3-bt2-1	36.047	1.733	19.017	18.604	0.145	11.094	0.073	0.195	9.01	0.068	0	0.23	96.119
0174-gt3-bt2-2	36.079	1.814	19.017	18.879	0.156	11.035	0.022	0.196	9.182	0.063	0.004	0.183	96.552
0174-gt3-bt2-3	35.423	1.9	18.943	18.835	0.097	11.009	0.011	0.107	8.934	0.087	0.003	0.141	95.43
0174-gt3-bt3-1	36.193	1.865	18.777	18.563	0.162	11.151	0.003	0.148	9.357	0.025	0.004	0.199	96.362
0174-gt3-bt3-2	35.885	2.033	18.605	18.727	0.144	11.04	0.005	0.189	9.19	0.009	0.01	0.14	95.916
0174-gt3-bt3-3	35.926	1.833	18.585	18.656	0.146	11.149	0.022	0.158	9.064	0.083	0.017	0.149	95.721

Cation proportions

Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Cr	Cl	F	Total
5.3993	0.2051	3.0525	2.411	0.0302	2.8869	0.0046	0.0652	1.5158	0.0227	0.0004	0.0549	15.6487
5.4511	0.2006	3.0715	2.3415	0.0214	2.7675	0.0007	0.0883	1.6413	0.0215	0	0.0612	15.6666
5.4617	0.1939	3.0685	2.3079	0.0226	2.7775	0.0054	0.0636	1.7182	0.02	0	0.0517	15.6911
5.4794	0.2128	3.0645	2.3059	0.0243	2.7068	0.0057	0.0823	1.6872	0.0173	0.0046	0.0608	15.6517
5.4637	0.2045	3.0692	2.3527	0.0236	2.746	0	0.0584	1.672	0.0159	0	0.0485	15.6546
5.4962	0.1935	3.0772	2.2815	0.023	2.7165	0.0039	0.0656	1.7029	0.0135	0.0011	0.0743	15.6492
5.4507	0.2035	3.0633	2.3363	0.0249	2.7297	0.0044	0.0696	1.6976	0.0196	0.0067	0.0815	15.6878
5.4393	0.2064	3.0385	2.3785	0.0234	2.7193	0.0031	0.0519	1.7375	0.0232	0.0036	0.0936	15.7183
3.9985	0.0094	4.5666	3.0961	0.0596	3.9664	0.0027	0.0063	0.0057	0.0025	0	0	15.7138
4.011	0.0123	4.5084	3.0659	0.0594	4.005	0	0.0059	0.0089	0.0286	0	0.0104	15.7158
3.9708	0.0129	4.582	3.1119	0.0531	3.9856	0.0051	0	0.0032	0	0.0024	0	15.727
4.0034	0.0066	4.5789	3.0552	0.0491	3.984	0	0.005	0.0087	0.011	0	0	15.702
3.9964	0.01	4.5367	3.1634	0.0564	3.9289	0.0094	0.0059	0.0079	0.0099	0.0024	0	15.7273
3.9893	0.0055	4.5642	3.071	0.0583	4.0103	0.0037	0	0.005	0.0119	0.0004	0	15.7197
3.9702	0.009	4.612	3.1232	0.0548	3.941	0.0014	0	0.0063	0	0	0	15.7179
3.9978	0.0103	4.5293	3.1354	0.0563	3.9549	0.0009	0	0.0073	0.0205	0	0.008	15.7207
3.9645	0.0063	4.6104	3.1219	0.0586	3.9489	0.0006	0	0.0058	0.0065	0	0	15.7236
3.9714	0.0069	4.5728	3.121	0.0587	3.9824	0.0019	0.0032	0.0074	0.0038	0.0095	0	15.739
3.9849	0.0078	4.5898	3.0754	0.0567	3.9671	0.0017	0	0.0118	0.0016	0	0.0207	15.7175
5.3907	0.2067	3.3161	2.3449	0.0199	2.5031	0.0081	0.0426	1.7054	0.0052	0	0.0732	15.6159
5.3685	0.1961	3.3577	2.3262	0.0163	2.5027	0.0026	0.0487	1.7405	0.0079	0	0.0802	15.6475
5.4166	0.203	3.36	2.2887	0.0118	2.4646	0	0.0439	1.7265	0.0073	0	0.0597	15.5821
5.3835	0.2082	3.3268	2.2989	0.0177	2.4872	0.0001	0.0573	1.755	0.0087	0	0.1032	15.6467
5.3971	0.2451	3.2823	2.3113	0.0149	2.4281	0.0054	0.0378	1.7673	0.0151	0	0.1072	15.6117
5.3551	0.2133	3.3266	2.3633	0.0173	2.5173	0.0141	0.048	1.6956	0.0062	0	0.0803	15.6371
5.3838	0.2244	3.2932	2.3277	0.0197	2.483	0.0036	0.0413	1.7385	0.008	0.0063	0.1016	15.6311
5.3529	0.2014	3.2626	2.5444	0.0133	2.5294	0.0111	0.0299	1.6088	0.0061	0.0018	0.069	15.6307
5.3812	0.2351	3.3122	2.3196	0.017	2.4945	0.0049	0.0455	1.7297	0.0114	0.0014	0.0568	15.6093
5.4149	0.1851	3.3336	2.2914	0.0181	2.474	0.0039	0.0363	1.7872	0.0044	0	0.0939	15.6428
5.402	0.1904	3.3385	2.317	0.0183	2.4999	0.006	0.0463	1.7517	0.0027	0	0.0634	15.6363
5.4013	0.1919	3.353	2.2905	0.0116	2.4904	0.0036	0.0505	1.7666	0.0067	0.0032	0.0662	15.6355
5.3965	0.182	3.3549	2.3255	0.0161	2.4825	0.0066	0.045	1.7736	0.0061	0	0.0613	15.6501
5.4116	0.1814	3.3451	2.3167	0.0143	2.4651	0.0113	0.0567	1.7465	0.0046	0.0014	0.0789	15.6336
5.4059	0.1823	3.3335	2.3196	0.0165	2.5018	0.004	0.0494	1.7513	0.006	0	0.0721	15.6424
5.3929	0.1924	3.3401	2.3258	0.0168	2.472	0.0159	0.0563	1.6973	0.0074	0.0053	0.0956	15.6178
5.3512	0.2107	3.3214	2.4114	0.0188	2.5294	0.0065	0.0404	1.6402	0.0054	0.0014	0.0782	15.615
5.3815	0.2239	3.3459	2.3106	0.0157	2.4677	0.0066	0.0439	1.7255	0.0072	0.0025	0.0719	15.6029
5.3794	0.1952	3.3551	2.3358	0.0159	2.4352	0.0046	0.0574	1.762	0.0096	0	0.1027	15.6529
5.1963	0.1874	3.3178	2.8256	0.0128	2.5004	0.0158	0.0359	1.5294	0.0062	0.0025	0.1068	15.7369
5.369	0.2315	3.3474	2.3617	0.0216	2.4332	0.0056	0.0424	1.6869	0.0098	0	0.0764	15.5855
5.3814	0.1946	3.3463	2.3228	0.0184	2.4688	0.0117	0.0566	1.7161	0.0081	0	0.1085	15.6334
5.3773	0.2033	3.3408	2.3532	0.0197	2.4516	0.0035	0.0566	1.7459	0.0075	0.0011	0.0862	15.6467
5.3447	0.2156	3.3688	2.3768	0.0124	2.4761	0.0017	0.0312	1.7198	0.0104	0.0007	0.0675	15.6257
5.3998	0.2093	3.3021	2.3162	0.0205	2.4801	0.0004	0.0428	1.7811	0.0029	0.0011	0.094	15.6503
5.3894	0.2296	3.2935	2.3522	0.0183	2.4718	0.0008	0.055	1.7609	0.0011	0.0025	0.0665	15.6417
5.3996	0.2073	3.2926	2.3451	0.0186	2.4981	0.0035	0.0461	1.7381	0.0098	0.0043	0.071	15.6342

Appendix 1 Mineral Chemistry

Biotite Data

Weight Percent Oxide

Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Cl	F	Total
2236bgt1-bt1-1	31.633	1.855	18.786	21.055	0.159	13.729	0.185	0.174	3.573	0.087	0.045	0.188	91.38
2236bgt1-bt1-2	35.233	2.092	18.848	19.102	0.061	10.48	0.039	0.323	8.492	0.076	0.029	0.182	94.873
2236bgt1-bt1-3	33.685	1.868	18.82	19.276	0.133	12.229	0.048	0.227	6.039	0.112	0.001	0.143	92.521
2236bgt1-bt2-1	26.379	0.058	21.415	27.119	0.275	13.546	0.064	0	0.055	0.07	0.013	0.032	89.01
2236bgt1-bt2-2	31.909	1.469	19.16	20.682	0.149	13.732	0.243	0.141	3.894	0.101	0.007	0.125	91.557
2236bgt1-bt2-3	32.174	1.834	18.948	21.887	0.122	12.118	0.038	0.104	5.615	0.086	0.027	0.205	93.066
2236bgt1-bt3-1	35.221	2.093	18.786	19.664	0.101	10.553	0.011	0.263	8.515	0.076	0	0.139	95.363
2236bgt1-bt3-2	35.609	2.107	19.068	18.933	0.045	10.961	0.069	0.361	8.33	0.078	0	0.122	95.632
2236bgt1-bt3-3	35.927	2.094	18.978	19.002	0.097	10.349	0.015	0.361	8.914	0.072	0.017	0.206	95.941
2236bgt2-bt1-1	26.464	0.016	21.322	25.517	0.264	14.57	0.087	0.081	0.03	0.062	0.037	0.041	88.466
2236bgt2-bt1-2	24.989	0	22.943	27.175	0.421	12.592	0.03	0.015	0.073	0	0.031	0	88.262
2236bgt2-bt1-3	62.39	0.059	18.123	0.042	0.036	0	0	0.125	16.26	0	0.017	0	97.049
2236bgt2-bt2-1	31.014	1.813	18.876	19.582	0.175	14.151	0.147	0.136	2.688	0.188	0.035	0.131	88.873
2236bgt2-bt2-2	33.66	1.668	19.212	19.884	0.086	11.665	0.099	0.234	6.67	0.171	0	0.219	93.476
2236bgt2-bt2-3	30.531	1.435	19.976	21.535	0.137	12.32	0.18	0.204	4.752	0.193	0.064	0.125	91.385
2236bgt2-bt3-1	32.195	1.542	19.043	19.66	0.152	13.134	0.099	0.193	4.873	0.188	0.006	0.176	91.186
2236bgt2-bt3-2	32.463	1.383	19.104	19.17	0.15	13.417	0.043	0.17	4.928	0.176	0.013	0.202	91.131
2236bgt2-bt3-3	28.162	0.209	20.29	21.038	0.237	17.179	0.077	0.038	0.364	0.18	0	0	87.774
2236bgt3-bt1-1	33.317	1.71	19.289	19.467	0.145	12.966	0.013	0.197	5.468	0.123	0.007	0.159	92.792
2236bgt3-bt1-2	31.72	1.369	19.118	19.558	0.138	14.485	0.106	0.111	3.326	0.099	0.041	0.161	90.155
2236bgt3-bt1-3	29.301	0.342	19.98	19.82	0.218	17.035	0.012	0.052	1.067	0.117	0	0.033	87.963
2236bgt3-bt2-1	28.785	0.409	20.308	22.905	0.273	14.896	0.047	0.036	1.306	0.092	0.001	0.046	89.085
2236bgt3-bt2-2	35.571	2.141	19.03	18.46	0.077	10.796	0.036	0.25	8.589	0.132	0	0.158	95.173
2236bgt3-bt2-3	35.76	2.097	19.296	19.08	0.059	10.423	0.005	0.313	8.696	0.092	0.001	0.118	95.89
2236bgt3-bt3-1	35.465	1.948	18.933	18.775	0.056	10.582	0.09	0.258	8.288	0.105	0.01	0.136	94.587
2236bgt3-bt3-2	35.222	2.098	18.967	18.908	0.041	10.314	0.07	0.303	8.453	0.114	0.006	0.131	94.571
0383-gt1-bt1-1	36.806	1.117	17.845	17.21	0.031	13.688	0.07	0.479	7.847	0.092	0	0.204	95.303
0383-gt1-bt1-2	37.029	1.236	18.066	16.753	0.079	13.542	0.061	0.376	7.936	0.075	0.007	0.16	95.251
0383-gt1-bt1-3	36.95	1.455	17.908	16.761	0.054	13.496	0.053	0.384	7.896	0.088	0.028	0.177	95.169
0383-gt1-bt2-1	37.579	1.188	18.34	16.122	0.057	13.506	0.053	0.436	7.645	0.07	0	0.257	95.145
0383-gt1-bt2-2	37.684	1.251	18.259	16.474	0.063	13.619	0.099	0.386	7.995	0.092	0.01	0.192	96.041
0383-gt1-bt2-3	37.391	1.122	18.35	16.707	0.079	13.584	0.052	0.428	8.077	0.091	0.013	0.239	96.029
0383-gt1-bt3-1	37.556	1.292	18.258	16.6	0.058	13.562	0.062	0.399	8.296	0.086	0.004	0.229	96.305
0383-gt1-bt3-2	37.055	1.301	17.843	17.171	0.084	13.558	0.017	0.399	7.808	0.093	0.013	0.216	95.464
0383-gt1-bt3-3	35.687	1.134	17.98	17.672	0.072	13.83	0.054	0.324	7.019	0.095	0.006	0.179	93.976
0383-gt2-bt1-1	37.422	1.347	18.172	16.472	0.016	13.7	0.097	0.411	7.618	0.121	0.025	0.2	95.511
0383-gt2-bt1-2	37.037	1.224	18.149	16.575	0.069	13.485	0.157	0.413	7.735	0.104	0.025	0.232	95.101
0383-gt2-bt2-1	37.114	1.471	18.043	16.398	0.065	13.181	0.1	0.37	8.014	0.18	0.008	0.22	95.069
0383-gt2-bt2-2	37.283	1.333	18.251	16.248	0.086	13.232	0.054	0.294	8.136	0.149	0.014	0.294	95.247
0383-gt2-bt2-3	37.165	1.45	18.073	16.842	0.052	13.374	0.071	0.386	7.843	0.105	0	0.204	95.479
0383-gt2-bt3-1	37.172	1.344	17.903	16.545	0.041	13.145	0.066	0.419	8.117	0.116	0.011	0.167	94.974
0383-gt2-bt3-2	37.083	1.414	17.916	16.487	0.087	13.242	0.067	0.454	8.178	0.09	0.003	0.227	95.151
0383-gt2-bt3-3	36.706	1.223	18.02	16.942	0.047	13.435	0.098	0.32	7.732	0.103	0	0.262	94.778
0220-gt1-bt1-1	36.207	1.874	18.856	18.483	0.104	10.993	0.095	0.275	8.444	0.069	0.014	0.105	95.472
0220-gt1-bt1-2	35.943	1.708	19.243	18.444	0.132	11.064	0.057	0.272	8.63	0.078	0.001	0.154	95.661
0220-gt1-bt1-3	36.329	1.872	19.136	18.771	0.133	11.006	0.087	0.228	8.518	0.091	0.017	0.102	96.243

Cation proportions

Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Cr	Cl	F	Total
4.9391	0.2178	3.4574	2.7494	0.0211	3.1953	0.031	0.0526	0.7118	0.0108	0.0119	0.093	15.4912
5.3429	0.2386	3.369	2.4226	0.0078	2.3691	0.0063	0.0949	1.6429	0.0092	0.0075	0.0874	15.5982
5.1958	0.2167	3.4217	2.4866	0.0174	2.8118	0.008	0.068	1.1884	0.0136	0.0004	0.0697	15.4981
4.3269	0.0072	4.1403	3.7202	0.0382	3.3122	0.0113	0	0.0116	0.0091	0.0035	0.0165	15.597
4.9714	0.1721	3.5187	2.6949	0.0197	3.1893	0.0405	0.0427	0.774	0.0124	0.0019	0.0618	15.4994
4.9988	0.2143	3.47	2.844	0.016	2.8067	0.0063	0.0314	1.1129	0.0105	0.007	0.1008	15.6187
5.333	0.2383	3.3528	2.4901	0.0129	2.382	0.0017	0.0773	1.6449	0.0091	0	0.0666	15.6087
5.3464	0.2379	3.3745	2.3773	0.0058	2.4532	0.0112	0.105	1.5955	0.0093	0	0.0581	15.5742
5.385	0.236	3.353	2.382	0.0123	2.3124	0.0024	0.105	1.7046	0.0085	0.0042	0.0976	15.6031
4.3323	0.002	4.1142	3.4936	0.0366	3.5555	0.0153	0.0256	0.0062	0.008	0.0102	0.0212	15.6207
4.1478	0	4.4887	3.7723	0.0592	3.1157	0.0052	0.0049	0.0154	0	0.0087	0	15.618
8.1945	0.0058	2.8057	0.0047	0.004	0	0	0.0318	2.7247	0	0.0038	0	13.775
4.9281	0.2167	3.5353	2.6023	0.0236	3.352	0.0251	0.042	0.545	0.0236	0.0095	0.0661	15.3694
5.165	0.1925	3.4747	2.5517	0.0112	2.6683	0.0163	0.0697	1.3058	0.0207	0	0.1064	15.5823
4.8258	0.1706	3.7216	2.8467	0.0184	2.9029	0.0305	0.0624	0.9582	0.0241	0.0172	0.0625	15.6409
5.0334	0.1813	3.5092	2.5706	0.0201	3.0609	0.0165	0.0584	0.9719	0.0232	0.0015	0.0872	15.5342
5.0591	0.1621	3.5094	2.4986	0.0198	3.117	0.0073	0.0514	0.9798	0.0217	0.0033	0.0994	15.5289
4.5396	0.0253	3.8551	2.8361	0.0323	4.1281	0.0133	0.012	0.0748	0.0229	0	0	15.5395
5.1115	0.1973	3.4882	2.4978	0.0189	2.9654	0.0021	0.0586	1.0703	0.0149	0.0018	0.0773	15.5041
4.9701	0.1613	3.5308	2.5629	0.0184	3.3834	0.0178	0.0338	0.6648	0.0122	0.0108	0.08	15.4463
4.6853	0.0412	3.7658	2.6506	0.0295	4.0605	0.002	0.0161	0.2177	0.0148	0	0.0167	15.5002
4.6271	0.0495	3.8478	3.0794	0.0372	3.5696	0.008	0.0113	0.2678	0.0117	0.0004	0.0234	15.5332
5.3592	0.2426	3.3794	2.326	0.0099	2.4247	0.0059	0.073	1.6509	0.0157	0	0.0753	15.5626
5.3637	0.2366	3.4114	2.3934	0.0076	2.3305	0.0007	0.0909	1.6641	0.0109	0.0003	0.0559	15.566
5.3785	0.2222	3.3844	2.3813	0.0072	2.3923	0.0147	0.0758	1.6036	0.0126	0.0025	0.0654	15.5405
5.3559	0.2399	3.3994	2.4046	0.0053	2.338	0.0115	0.0894	1.6399	0.0137	0.0014	0.0632	15.5622
5.4725	0.1249	3.1274	2.14	0.0039	3.0339	0.0111	0.1382	1.4885	0.0108	0	0.0959	15.6471
5.496	0.1379	3.1606	2.0795	0.0099	2.9963	0.0098	0.1081	1.5028	0.0088	0.0018	0.0753	15.5869
5.4884	0.1625	3.1353	2.0821	0.0068	2.9884	0.0084	0.1106	1.4964	0.0104	0.007	0.0833	15.5796
5.538	0.1316	3.1857	1.987	0.0071	2.967	0.0083	0.1247	1.4373	0.0081	0	0.1196	15.5145
5.5279	0.138	3.157	2.021	0.0078	2.978	0.0156	0.1098	1.4962	0.0107	0.0024	0.0889	15.5533
5.4947	0.1239	3.1784	2.0532	0.0099	2.9758	0.0082	0.1219	1.5144	0.0105	0.0031	0.111	15.6051
5.5059	0.1425	3.1551	2.0353	0.0072	2.9639	0.0097	0.1134	1.5518	0.0099	0.001	0.106	15.6017
5.4913	0.145	3.1167	2.1282	0.0105	2.9952	0.0027	0.1146	1.4762	0.0109	0.0032	0.101	15.5956
5.3825	0.1287	3.1965	2.2292	0.0092	3.1095	0.0088	0.0949	1.3506	0.0113	0.0014	0.0854	15.608
5.511	0.1492	3.1543	2.0286	0.002	3.0074	0.0153	0.1173	1.4313	0.0141	0.0063	0.0933	15.5301
5.4896	0.1364	3.1707	2.0546	0.0086	2.9795	0.0249	0.1187	1.4627	0.0122	0.0063	0.109	15.5733
5.5072	0.1642	3.1557	2.035	0.0082	2.9156	0.0156	0.1064	1.5172	0.0212	0.0021	0.1034	15.552
5.5089	0.1481	3.1787	2.0079	0.0108	2.9145	0.0086	0.0843	1.5337	0.0175	0.0035	0.1375	15.5541
5.4964	0.1613	3.1505	2.0831	0.0066	2.9486	0.0113	0.1106	1.4798	0.0123	0	0.0956	15.5561
5.5321	0.1505	3.1405	2.0592	0.0051	2.9162	0.0106	0.1209	1.5411	0.0137	0.0028	0.0787	15.5715
5.5075	0.158	3.1364	2.0478	0.011	2.9317	0.0107	0.1306	1.5496	0.0106	0.0007	0.1066	15.6013
5.4694	0.137	3.1648	2.1113	0.0059	2.9842	0.0157	0.0925	1.4698	0.0122	0	0.1235	15.5863
5.43	0.2113	3.3332	2.3182	0.0132	2.4577	0.0152	0.0799	1.6155	0.0082	0.0035	0.0496	15.5355
5.3823	0.1923	3.3964	2.3098	0.0168	2.4698	0.0091	0.0788	1.6486	0.0092	0.0003	0.0729	15.5863
5.4101	0.2097	3.359	2.3378	0.0168	2.4432	0.0138	0.0657	1.6184	0.0107	0.0042	0.048	15.5374

Appendix 1 Mineral Chemistry

Biotite Data

Weight Percent Oxide

Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Cl	F	Total
0220-gt1-bt2-2	36.395	1.594	19.439	18.109	0.106	11.057	0.021	0.212	9.175	0.124	0	0.137	96.311
0220-gt1-bt2-3	36.115	1.767	19.033	18.823	0.097	11.028	0.026	0.212	8.577	0.085	0	0.092	95.816
0220-gt1-bt3-3	35.881	1.877	19.058	18.748	0.136	11.145	0.028	0.241	8.713	0.098	0	0.086	95.975
0220-gt1-bt3-1	36.108	1.768	19.195	18.428	0.099	11.176	0.027	0.269	8.815	0.11	0	0.141	96.077
0220-gt1-bt3-2	35.943	1.892	19	18.763	0.104	11.248	0.004	0.252	8.492	0.09	0	0.126	95.861
0220-gt1-bt3-3	36.212	1.618	19.154	18.19	0.121	11.217	0.048	0.26	8.32	0.096	0.014	0.164	95.342
0220-gt2-bt1-1	35.455	2.01	18.955	18.544	0.061	11.225	0.021	0.157	8.924	0.116	0.001	0.036	95.49
0220-gt2-bt1-2	36.227	1.752	18.911	18.404	0.1	11.328	0.028	0.212	8.684	0.099	0.011	0.174	95.855
0220-gt2-bt1-3	36.158	1.727	19.11	18.249	0.075	11.379	0.039	0.233	8.723	0.111	0.003	0.156	95.896
0220-gt2-bt2-1	35.912	1.798	18.998	18.363	0.078	10.947	0.04	0.214	8.586	0.115	0	0.162	95.147
0220-gt2-bt2-2	35.951	1.874	19.061	18.53	0.051	11.094	0.071	0.239	8.289	0.129	0	0.102	95.348
0220-gt2-bt2-3	34.99	1.664	18.949	18.711	0.081	11.299	0.111	0.205	7.936	0.103	0	0.142	94.131
0220-gt2-bt3-1	36.571	1.613	19.292	17.95	0.069	11.495	0.1	0.241	8.766	0.091	0	0.143	96.271
0220-gt2-bt3-2	35.952	1.624	18.947	18.909	0.07	11.136	0.088	0.242	8.591	0.07	0.014	0.102	95.699
0220-gt2-bt3-3	36.388	1.599	19.223	18.057	0.101	11.42	0.135	0.269	8.368	0.09	0.014	0.151	95.748
0244-gt1-bt1-1	35.681	1.836	19.418	17.864	0.12	11.152	0	0.192	9.003	0.081	0	0.125	95.419
0244-gt1-bt1-2	36.003	1.877	19.385	18.378	0.128	11.284	0.019	0.165	9.107	0.106	0.008	0.114	96.524
0244-gt1-bt1-3	35.7	1.719	19.526	18.013	0.129	10.808	0.056	0.231	9.071	0.088	0	0.19	95.451
0244-gt1-bt2-1	35.395	1.632	19.446	17.922	0.186	10.734	0.078	0.18	8.597	0.079	0.012	0.157	94.349
0244-gt1-bt2-2	35.952	1.586	19.488	17.926	0.171	11.176	0.081	0.229	8.792	0.078	0	0.196	95.592
0244-gt1-bt2-3	35.975	1.781	19.454	17.985	0.117	10.993	0.115	0.183	8.864	0.124	0	0.146	95.676
0244-gt1-bt3-1	35.585	1.72	19.434	18.108	0.195	11.007	0.041	0.212	9.174	0.089	0	0.16	95.658
0244-gt1-bt3-2	35.928	1.726	19.391	18.057	0.155	11.07	0.005	0.292	9.134	0.103	0.029	0.156	95.973
0293-gt1-bt1-1	35.497	1.519	18.975	18.862	0.076	10.415	0.012	0.199	9.183	0.07	0	0.254	94.955
0293-gt1-bt1-2	36.172	1.517	19.138	18.857	0.055	10.611	0.02	0.207	9.214	0.088	0.003	0.281	96.044
0293-gt1-bt1-3	35.517	1.492	19.084	18.923	0.063	10.468	0.048	0.141	9.082	0.101	0.01	0.14	95.008
0293-gt1-bt2-1	36.194	1.376	19.157	19.182	0.067	10.362	0.049	0.196	9.101	0.066	0.008	0.244	95.897
0293-gt1-bt2-2	35.806	1.506	19.218	19.112	0.078	10.37	0.036	0.149	9.17	0.043	0.019	0.233	95.638
0293-gt1-bt2-3	35.875	1.558	19.183	19.002	0.048	10.476	0.054	0.112	9.101	0.087	0.007	0.192	95.612
0293-gt1-bt3-1	35.866	1.686	18.858	19.302	0.075	10.337	0.06	0.181	9.042	0.078	0	0.167	95.582
0293-gt1-bt3-2	36.391	1.653	18.986	18.927	0.078	10.446	0.069	0.137	8.871	0.085	0	0.151	95.73
0293-gt1-bt3-3	35.471	1.506	18.944	19.079	0.088	10.387	0.024	0.138	8.967	0.091	0.007	0.171	94.799
0293-gt2-bt1-1	36.103	1.634	19.127	19.637	0.103	10.533	0.03	0.177	9.126	0.066	0.001	0.2	96.653
0293-gt2-bt1-2	35.741	1.496	19.117	19.534	0.097	10.51	0.024	0.156	9.223	0.09	0.004	0.239	96.129
0293-gt2-bt1-3	35.782	1.496	18.82	19.045	0.059	10.654	0.04	0.126	9.099	0.045	0.008	0.25	95.317
0293-gt2-bt2-1	35.719	1.38	18.849	19.25	0.056	10.367	0.076	0.1	8.838	0.068	0	0.24	94.842
0293-gt2-bt2-2	35.924	1.585	19.098	19.226	0.067	10.521	0.026	0.128	9.293	0.075	0.024	0.203	96.08
0293-gt2-bt2-3	35.627	1.349	19.352	19.125	0.035	10.449	0.008	0.151	9.205	0.065	0.014	0.145	95.461
0293-gt2-bt3-1	35.621	1.553	19.273	19.048	0.08	10.516	0.05	0.147	9.204	0.092	0.007	0.176	95.691
0293-gt2-bt3-2	35.51	1.687	18.992	18.992	0.071	10.3	0	0.146	9.16	0.074	0.026	0.192	95.063
0293-gt2-bt3-3	35.444	1.574	19.097	18.777	0.048	10.335	0.022	0.19	9.244	0.09	0.019	0.193	94.948
0293-gt3-bt1-1	35.558	1.554	18.992	19.404	0.067	10.362	0.031	0.124	9.476	0.077	0.007	0.228	95.782
0293-gt3-bt1-2	35.795	1.688	19.2	19.902	0.074	10.173	0.025	0.191	9.179	0.083	0.008	0.192	96.427
0293-gt3-bt1-3	35.374	1.554	19.289	19.492	0.094	10.398	0	0.138	9.138	0.048	0.003	0.209	95.648
0293-gt3-bt2-1	35.22	1.584	19.091	19.795	0.086	10.426	0.007	0.175	9	0.045	0.015	0.196	95.554
0293-gt3-bt2-2	35.084	1.643	19.005	19.542	0.083	10.116	0.04	0.152	8.829	0.08	0.025	0.18	94.697

Cation proportions

Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Cr	Cl	F	Total
5.4125	0.1782	3.4074	2.2523	0.0133	2.4512	0.0033	0.0611	1.7407	0.0146	0	0.0645	15.5991
5.4086	0.199	3.3598	2.3576	0.0123	2.4619	0.0042	0.0616	1.6388	0.0101	0	0.0437	15.5577
5.3737	0.2114	3.3643	2.3481	0.0172	2.4881	0.0044	0.07	1.6647	0.0116	0	0.041	15.5946
5.3872	0.1983	3.3756	2.2994	0.0125	2.4857	0.0044	0.0778	1.6779	0.0129	0	0.0663	15.5981
5.3775	0.2129	3.3507	2.3477	0.0132	2.5086	0.0006	0.0731	1.6209	0.0107	0	0.0596	15.5758
5.4185	0.1821	3.3782	2.2763	0.0153	2.502	0.0076	0.0755	1.5884	0.0114	0.0035	0.0777	15.5365
5.3476	0.228	3.3699	2.3392	0.0078	2.5238	0.0034	0.046	1.7173	0.0138	0.0004	0.0171	15.6143
5.4088	0.1967	3.328	2.298	0.0126	2.5213	0.0045	0.0614	1.6541	0.0117	0.0028	0.0822	15.5821
5.3949	0.1938	3.3608	2.2772	0.0095	2.5308	0.0062	0.0673	1.6605	0.0131	0.0007	0.0734	15.5882
5.4027	0.2034	3.3688	2.3105	0.0099	2.4551	0.0064	0.0624	1.6484	0.0136	0	0.0769	15.5581
5.3963	0.2116	3.3723	2.326	0.0065	2.4824	0.0114	0.0695	1.5873	0.0153	0	0.0482	15.5268
5.3273	0.1906	3.4005	2.3825	0.0105	2.5644	0.0181	0.0605	1.5416	0.0124	0	0.0685	15.577
5.4224	0.1799	3.3716	2.2258	0.0087	2.5406	0.016	0.0693	1.6582	0.0107	0	0.0672	15.5704
5.3968	0.1833	3.3525	2.3739	0.009	2.4919	0.0141	0.0706	1.6453	0.0083	0.0035	0.0483	15.5975
5.4189	0.1791	3.3742	2.2489	0.0127	2.5351	0.0215	0.0777	1.5898	0.0106	0.0035	0.0712	15.5432
5.3566	0.2073	3.4362	2.2429	0.0153	2.4958	0	0.0558	1.7244	0.0096	0	0.0595	15.6034
5.3556	0.21	3.3989	2.2864	0.0161	2.5022	0.0031	0.0475	1.7284	0.0125	0.0021	0.0538	15.6166
5.3585	0.194	3.4545	2.2613	0.0164	2.4184	0.0089	0.0672	1.7372	0.0105	0	0.0901	15.6171
5.3656	0.1861	3.4746	2.2722	0.0239	2.4257	0.0127	0.0529	1.6627	0.0095	0.0032	0.0753	15.5645
5.3742	0.1783	3.4336	2.2411	0.0217	2.4904	0.013	0.0664	1.6766	0.0092	0	0.0929	15.5974
5.3799	0.2003	3.4291	2.2493	0.0148	2.4506	0.0184	0.053	1.6911	0.0146	0	0.069	15.5702
5.3422	0.1942	3.4388	2.2735	0.0247	2.4633	0.0066	0.0617	1.757	0.0106	0	0.0758	15.6484
5.3679	0.1939	3.4148	2.2562	0.0196	2.4656	0.0008	0.0846	1.741	0.0121	0.0074	0.0735	15.6374
5.3806	0.1731	3.3901	2.3911	0.0097	2.3533	0.0019	0.0584	1.7758	0.0084	0	0.1216	15.664
5.4063	0.1705	3.3716	2.357	0.007	2.3642	0.0032	0.0599	1.757	0.0104	0.0007	0.133	15.6409
5.3864	0.1702	3.4114	2.4	0.0081	2.3666	0.0078	0.0416	1.7573	0.0121	0.0025	0.0671	15.6312
5.4247	0.155	3.3843	2.4044	0.0085	2.315	0.0079	0.057	1.7402	0.0078	0.0021	0.1157	15.6226
5.3874	0.1704	3.4082	2.4049	0.01	2.3259	0.0058	0.0434	1.7602	0.0052	0.005	0.1111	15.6375
5.3965	0.1762	3.4013	2.3905	0.0061	2.3491	0.0087	0.0327	1.7466	0.0103	0.0018	0.0911	15.6109
5.4098	0.1913	3.3528	2.435	0.0096	2.3242	0.0096	0.0531	1.7401	0.0094	0	0.0795	15.6144
5.4557	0.1863	3.3549	2.3731	0.01	2.3346	0.0111	0.0399	1.6968	0.01	0	0.0714	15.5438
5.391	0.1722	3.3936	2.425	0.0114	2.3532	0.0038	0.0406	1.7386	0.0109	0.0018	0.082	15.6241
5.3872	0.1834	3.3641	2.4506	0.0131	2.343	0.0049	0.0513	1.7374	0.0078	0.0004	0.0946	15.6378
5.3655	0.1689	3.3828	2.4524	0.0124	2.352	0.0039	0.0455	1.7663	0.0107	0.0011	0.1135	15.675
5.4002	0.1698	3.3478	2.4038	0.0075	2.3968	0.0065	0.0369	1.7519	0.0054	0.0021	0.1191	15.6479
5.4159	0.1574	3.3687	2.441	0.0071	2.3433	0.0123	0.0293	1.7096	0.0082	0	0.1149	15.6078
5.3885	0.1788	3.3766	2.4118	0.0086	2.3526	0.0042	0.0371	1.7784	0.0089	0.006	0.0963	15.6478
5.38	0.1532	3.4446	2.4153	0.0045	2.3521	0.0013	0.0443	1.7734	0.0077	0.0036	0.0695	15.6495
5.3648	0.1759	3.4214	2.3993	0.0103	2.361	0.008	0.043	1.7686	0.0109	0.0018	0.0838	15.6489
5.3818	0.1923	3.3928	2.4072	0.0091	2.3271	0	0.0429	1.7712	0.0089	0.0068	0.0921	15.6322
5.3768	0.1795	3.4146	2.3822	0.0062	2.3372	0.0036	0.056	1.789	0.0107	0.005	0.0924	15.6532
5.3658	0.1763	3.3782	2.4489	0.0086	2.3311	0.005	0.0363	1.8244	0.0092	0.0018	0.1089	15.6945
5.3667	0.1903	3.3931	2.4956	0.0095	2.2736	0.004	0.0554	1.7557	0.0099	0.0021	0.0911	15.647
5.3393	0.1764	3.4316	2.4605	0.012	2.3395	0	0.0404	1.7596	0.0058	0.0007	0.0997	15.6656
5.3304	0.1803	3.4056	2.5055	0.011	2.3523	0.0012	0.0513	1.7378	0.0054	0.0039	0.0938	15.6786
5.3503	0.1885	3.4161	2.4924	0.0107	2.2996	0.0065	0.045	1.7178	0.0096	0.0065	0.0869	15.6299

Appendix 1 Mineral Chemistry

Biotite Data

Weight Percent Oxide

Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Cr_2O_3	Cl	F	Total
0293-gt3-bt2-3	24.255	0.06	23.11	24.489	0.112	14.895	0.017	0.013	0.014	0.052	0.017	0	87.05
0293-gt3-bt3-1	29.825	0.117	22.223	22.663	0.124	12.931	0.049	0.717	0.552	0.041	0.011	0.011	89.257
0293-gt3-bt3-2	24.488	0.103	23.632	24.192	0.093	15.225	0.013	0.004	0.126	0.036	0.006	0.056	87.949
0293-gt3-bt3-3	35.794	1.546	19.231	19.186	0.048	10.511	0.034	0.173	8.881	0.055	0	0.154	95.548
1181gt1bt1-1	34.319	3.889	15.75	25.89	0.208	6.038		0.094	9.587		0.036		95.803
1181gt1bt1-2	33.867	3.709	15.715	26.069	0.197	6.11		0.069	9.209		0.036		94.993
1181gt1bt1-3	34.232	3.544	15.781	26.072	0.187	6.128		0.102	9.759		0.007		95.81
1181gt1bt2-1	34.37	3.388	15.621	26.016	0.19	6.189		0.162	9.633		0.04		95.6
1181gt1bt2-2	34.209	3.31	15.609	26.117	0.167	6.313		0.178	9.775		0.044		95.712
1181gt1bt2-3	33.704	2.563	16.188	25.789	0.162	6.696		0.004	9.821		0.091		94.997
1181gt1bt3-1	33.577	2.946	15.928	26.229	0.187	6.192		0.131	9.825		0.045		95.05
1181gt1bt3-2	33.565	2.974	15.783	25.995	0.176	6.273		0.139	9.681		0.081		94.649
1181gt1bt3-3	33.412	3.015	15.843	26.443	0.173	6.389		0.166	9.942		0.089		95.452
1047gt1bt1-1	36.207	1.745	18.215	17.436	0.034	11.22		0.257	8.94		0.024		94.075
1047gt1bt1-2	35.898	1.755	18.041	17.308	0.057	11.264		0.321	9.139		0.014		93.794
1047gt1bt1-3	35.416	1.661	18.223	17.929	0.045	11.106		0.237	8.191		0.043		92.841
1047gt1bt2-1	35.535	1.472	18.127	18.026	0.059	10.95		0.251	9.183		0.047		93.639
1047gt1bt2-2	35.81	1.598	18.622	17.652	0.055	11.074		0.245	9.103		0.01		94.167
1047gt1bt2-3	36.03	1.725	17.9	17.594	0.031	11.466		0.273	8.426		0		93.445
1047gt1bt3-1	35.514	1.899	17.747	18.033	0.049	11.333		0.268	8.641		0		93.484
1047gt1bt3-2	34.738	1.874	17.609	18.828	0.046	11.393		0.223	8.055		0.014		92.777
1047gt1bt3-3	35.59	1.989	17.941	17.437	0.044	11.365		0.337	8.543		0.001		93.247
1047gt2bt1-1	35.882	1.674	17.941	17.214	0.03	11.393		0.308	8.667		0.004		93.112
1047gt2bt1-2	36.407	1.662	18.42	17.232	0.092	11.012		0.27	9.055		0		94.15
1047gt2bt1-3	36.142	1.579	18.434	16.611	0.059	10.755		0.209	9.329		0.006		93.123
1047gt2bt2-1	35.877	1.71	18.501	17.137	0.075	10.787		0.256	9.287		0		93.63
1047gt2bt2-2	36.208	1.786	18.391	17.321	0.066	10.822		0.298	9.164		0		94.056
1047gt2bt2-3	35.906	1.649	18.462	17.245	0.063	10.743		0.269	8.967		0.015		93.316
1047gt2bt3-1	36.167	1.815	18.135	17.853	0.078	11.264		0.247	8.677		0.013		94.246
1047gt2bt3-2	36.176	1.879	18.414	17.172	0.044	11.243		0.284	9.201		0.035		94.44
1047gt2bt3-3	35.897	1.707	18.378	17.667	0.066	11.401		0.254	8.816		0.013		94.196
1107gt1bt1-1	35.151	2.338	19.638	17.689	0.06	9.468		0.127	10.07		0		94.549
1107gt1bt1-2	35.293	2.608	20.075	17.629	0.066	9.243		0.152	9.858		0		94.924
1107gt1bt1-3	35.55	2.491	19.606	18.152	0.073	9.141		0.043	10.032		0.001		95.089
1107gt1bt2-1	34.871	2.771	19.144	18.105	0.104	9.015		0.126	9.917		0		94.053
1107gt1bt2-2	34.801	2.603	18.97	18.45	0.095	8.903		0.06	10.077		0.001		93.96
1107gt1bt2-3	34.603	3.121	19.385	18.613	0.102	8.496		0.069	9.725		0		94.114
1107gt1bt3-1	34.959	3.053	19.171	18.487	0.104	8.525		0.079	10.017		0.007		94.4
1107gt1bt3-2	35.218	3.258	19.475	18.01	0.112	8.605		0.093	9.969		0		94.74
1107gt1bt3-3	34.412	2.983	18.574	19.056	0.126	9.005		0.124	9.642		0		93.922
1107gt1bt3-4m	34.787	3.195	19.272	17.654	0.108	8.659		0.106	9.835		0		93.616

Cation proportions

Analysis	Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Cr	Cl	F	Total
0293-gt3-bt2-3	4.0303	0.01	4.5263	3.4031	0.0158	3.6895	0.003	0.0043	0.0029	0.0068	0.0047	0	15.6967
0293-gt3-bt3-1	4.7323	0.014	4.1562	3.0073	0.0167	3.0584	0.0083	0.2205	0.1118	0.0052	0.003	0.0055	15.3392
0293-gt3-bt3-2	4.013	0.0127	4.5648	3.3156	0.0129	3.7193	0.0023	0.0014	0.0263	0.0046	0.0016	0.029	15.7035
0293-gt3-bt3-3	5.3902	0.1751	3.4135	2.4163	0.0062	2.3596	0.0055	0.0506	1.7062	0.0066	0	0.0733	15.6031
1181gt1bt1-1	2.6702	0.2271	1.5577	1.6732	0.0137	0.6957		0.014	0.9494		0.0047		7.8057
1181gt1bt1-2	2.6584	0.2185	1.568	1.701	0.013	0.7101		0.0104	0.9202		0.0048		7.8045
1181gt1bt1-3	2.6691	0.2073	1.5641	1.6885	0.0123	0.7075		0.0152	0.9685		0.0009		7.8335
1181gt1bt2-1	2.6833	0.1985	1.5502	1.6871	0.0125	0.7155		0.0243	0.9573		0.0053		7.8341
1181gt1bt2-2	2.6726	0.1941	1.5501	1.6949	0.0111	0.7303		0.0267	0.9721		0.0058		7.8578
1181gt1bt2-3	2.6483	0.1511	1.6167	1.6831	0.0107	0.779		0.0006	0.9822		0.0121		7.8839
1181gt1bt3-1	2.6474	0.1743	1.5963	1.7178	0.0124	0.7229		0.0199	0.986		0.0061		7.8832
1181gt1bt3-2	2.6534	0.1764	1.5859	1.707	0.0117	0.7343		0.0211	0.9742		0.0109		7.8749
1181gt1bt3-3	2.6296	0.178	1.5849	1.7287	0.0115	0.7446		0.0252	0.996		0.0119		7.9104
1047gt1bt1-1	2.7125	0.0981	1.7333	1.0845	0.0022	1.2447		0.037	0.8521		0.003		7.7674
1047gt1bt1-2	2.7038	0.0991	1.726	1.0823	0.0036	1.2564		0.0465	0.8758		0.0018		7.7953
1047gt1bt1-3	2.6882	0.0945	1.7568	1.1298	0.0029	1.2482		0.0347	0.791		0.0056		7.7517
1047gt1bt2-1	2.6919	0.0836	1.7442	1.1337	0.0038	1.2283		0.0366	0.8851		0.0061		7.8134
1047gt1bt2-2	2.6864	0.0899	1.7742	1.0993	0.0035	1.2301		0.0354	0.8687		0.0012		7.7887
1047gt1bt2-3	2.7148	0.0975	1.7132	1.1006	0.002	1.2794		0.0396	0.8078		0		7.755
1047gt1bt3-1	2.6896	0.1079	1.7073	1.1339	0.0032	1.271		0.039	0.8327		0		7.7847
1047gt1bt3-2	2.6583	0.1076	1.7118	1.1963	0.003	1.2911		0.0329	0.7843		0.0018		7.7872
1047gt1bt3-3	2.6915	0.1128	1.7235	1.0948	0.0028	1.2728		0.049	0.822		0.0002		7.7695
1047gt2bt1-1	2.7134	0.095	1.7233	1.0807	0.0019	1.2758		0.0448	0.8339		0.0005		7.7693
1047gt2bt1-2	2.7223	0.0932	1.7494	1.0697	0.0058	1.2192		0.0389	0.8614		0		7.76
1047gt2bt1-3	2.729	0.0894	1.7679	1.0412	0.0037	1.2024		0.0304	0.8961		0.0007		7.7609
1047gt2bt2-1	2.7034	0.0966	1.7707	1.072	0.0048	1.2035		0.0372	0.8903		0		7.7785
1047gt2bt2-2	2.7148	0.1004	1.7515	1.0781	0.0042	1.2015		0.0429	0.8741		0		7.7675
1047gt2bt2-3	2.7104	0.0934	1.77	1.0806	0.004	1.2007		0.0391	0.8611		0.002		7.7614
1047gt2bt3-1	2.7072	0.1019	1.7243	1.1094	0.0049	1.2486		0.0356	0.8264		0.0016		7.76
1047gt2bt3-2	2.7001	0.1052	1.7457	1.064	0.0028	1.2426		0.0408	0.8737		0.0044		7.7794
1047gt2bt3-3	2.689	0.0959	1.7486	1.0987	0.0041	1.2646		0.0366	0.8402		0.0016		7.7794
1107gt1bt1-1	2.6395	0.1316	1.8725	1.1024	0.0038	1.0522		0.0183	0.9626		0		7.7629
1107gt1bt1-2	2.6318	0.1458	1.9007	1.0911	0.0041	1.02		0.0217	0.9351		0		7.7503
1107gt1bt1-3	2.6555	0.1395	1.8597	1.1254	0.0046	1.0106		0.0062	0.9532		0.0002		7.755
1107gt1bt2-1	2.6408	0.1573	1.8411	1.1381	0.0066	1.0104		0.0183	0.9554		0		7.7681
1107gt1bt2-2	2.6458	0.1484	1.8316	1.1644	0.0061	1.0018		0.0087	0.9746		0.0002		7.7816
1107gt1bt2-3	2.622	0.1773	1.8652	1.1707	0.0065	0.9527		0.01	0.9374		0		7.7418
1107gt1bt3-1	2.6425	0.173	1.8403	1.1599	0.0066	0.9537		0.0115	0.9632		0.0009		7.7516
1107gt1bt3-2	2.6421	0.1832	1.8554	1.1214	0.0071	0.9554		0.0135	0.9513		0		7.7295
1107gt1bt3-3	2.6252	0.1706	1.7997	1.2068	0.0081	1.0168		0.0181	0.9358		0		7.7812
1107gt1bt3-4m	2.6392	0.1817	1.8567	1.1117	0.0069	0.9722		0.0155	0.9491		0		7.7331

Biotite data from microprobe session Jan 2001, analyses lacking data for CaO, Cr2O3, and F analyzed Jan 2002.

Appendix 1 Mineral Chemistry

Plagioclase Chemistry

Weight percent oxide									Cation ratio							
Analysis	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Total	Si	Al	Fe	Mg	Ca	Na	K	Total
ts396-gt1-plag1-1	57.569	27.276	0.229	0.002	8.706	6.761	0.092	100.635	2.5658	1.4329	0.0085	0.0001	0.4158	0.5843	0.0052	5.0127
ts396-gt1-plag1-2	57.682	26.791	0.318	0.185	6.659	6.32	1.597	99.552	2.599	1.4228	0.012	0.0124	0.3215	0.5522	0.0918	5.0117
ts396-gt1-plag1-3	57.355	27.584	0.107	0.036	9.013	6.427	0.156	100.678	2.5546	1.4481	0.004	0.0024	0.4301	0.5551	0.0088	5.0031
ts396-gt1-plag1-4	57.468	27.216	0.056	0	8.884	6.607	0.039	100.272	2.5676	1.4333	0.0022	0	0.4253	0.5724	0.0022	5.003
ts396-gt1-plag2-1	57.444	23.766	0.442	0.226	2.165	5.449	4.092	93.584	2.7382	1.3353	0.0176	0.0161	0.1106	0.5037	0.2488	4.9704
ts396-gt1-plag2-2	58.459	26.915	0.097	0	8.158	7.032	0.071	100.732	2.5954	1.4085	0.0036	0	0.3881	0.6053	0.004	5.005
ts396-gt1-plag2-1	57.344	27.434	0.037	0	8.867	6.741	0.054	100.477	2.5586	1.4428	0.0014	0	0.4239	0.5832	0.0031	5.0131
ts396-gt1-plag2-2	57.572	27.37	0.042	0	8.849	6.636	0.049	100.518	2.5657	1.4377	0.0016	0	0.4226	0.5734	0.0028	5.0038
ts396-gt1-plag2-3	58.834	26.823	0.037	0.006	8.149	7.135	0.076	101.06	2.6028	1.3987	0.0014	0.0004	0.3863	0.6121	0.0043	5.0061
ts396-gt1-plag3-1	57.592	27.45	0.054	0.008	8.707	6.684	0.077	100.572	2.5649	1.441	0.002	0.0006	0.4155	0.5772	0.0044	5.0057
ts396-gt1-plag3-2	57.872	27.318	0.085	0.005	8.832	6.824	0.064	101	2.5686	1.4292	0.0032	0.0004	0.42	0.5873	0.0036	5.0124
ts396-gt1-plag3-3	57.595	27.382	0.037	0	8.878	6.748	0.06	100.7	2.5637	1.4366	0.0014	0	0.4234	0.5824	0.0034	5.011
ts396-gt2-plag1-1	57.216	27.499	0.213	0.005	9.075	6.595	0.052	100.655	2.5516	1.4455	0.0079	0.0003	0.4337	0.5703	0.003	5.0124
ts396-gt2-plag1-2	57.591	27.676	0.151	0.002	9.047	6.469	0.069	101.005	2.556	1.4478	0.0056	0.0002	0.4302	0.5567	0.0039	5.0005
ts396-gt2-plag1-3	57.63	27.806	0.184	0.006	8.92	6.481	0.085	101.112	2.5545	1.4528	0.0068	0.0004	0.4236	0.557	0.0048	5
ts396-gt2-plag1-4	57.529	27.389	0.233	0.012	8.925	6.527	0.064	100.679	2.5621	1.4378	0.0087	0.0008	0.4259	0.5636	0.0037	5.0026
ts396-gt2-plag2-1	57.614	27.418	0.17	0	8.882	6.606	0.057	100.747	2.5634	1.4379	0.0063	0	0.4234	0.5699	0.0032	5.0041
ts396-gt2-plag2-2	58.435	27.961	0.116	0.012	9.118	6.761	0.05	102.453	2.5576	1.4425	0.0042	0.0008	0.4276	0.5738	0.0028	5.0093
ts396-gt2-plag2-3	57.536	27.343	0.099	0	9.035	6.738	0.07	100.821	2.5606	1.4344	0.0037	0	0.4308	0.5814	0.004	5.0149
ts396-gt2-plag2-4	57.681	27.533	0.1	0	8.921	6.72	0.069	101.024	2.5601	1.4404	0.0037	0	0.4243	0.5783	0.0039	5.0108
ts396-gt2-plag3-1	57.36	27.585	0.048	0	9.086	6.466	0.055	100.6	2.5554	1.4485	0.0018	0	0.4337	0.5586	0.0031	5.0012
ts396-gt2-plag3-2	58.145	27.01	0.051	0	8.409	6.815	0.048	100.478	2.588	1.4171	0.0019	0	0.401	0.5882	0.0028	4.9991
ts396-gt2-plag3-3	57.438	27.631	0.08	0	8.98	6.551	0.052	100.732	2.5556	1.4491	0.003	0	0.4281	0.5651	0.003	5.004
ts396-gt2-plag3-4	57.388	27.763	0.036	0	9.048	6.457	0.045	100.737	2.5523	1.4554	0.0013	0	0.4312	0.5569	0.0025	4.9997
ts396-gt2-plag4-1	57.123	27.149	0.064	0	8.942	6.67	0.081	100.029	2.5616	1.435	0.0024	0	0.4297	0.5799	0.0047	5.0134
ts396-gt2-plag4-2	57.345	27.252	0.009	0	8.97	6.699	0.071	100.346	2.5624	1.4354	0.0003	0	0.4295	0.5804	0.0041	5.0122
ts396-gt2-plag4-3	57.215	27.44	0.04	0	8.873	6.798	0.061	100.427	2.5554	1.4446	0.0015	0	0.4246	0.5887	0.0035	5.0183
ts396-gt2-plag4-4	57.196	27.421	0.049	0.019	8.872	6.583	0.066	100.206	2.558	1.4455	0.0018	0.0013	0.4252	0.5709	0.0038	5.0066
ts613-gt6-plag1-1	61.157	24.844	0.109	0	5.731	8.427	0.077	100.345	2.7077	1.2965	0.0041	0	0.2719	0.7235	0.0043	5.0081
ts613-gt6-plag1-2	61.029	24.6	0.041	0.003	5.834	8.378	0.074	99.959	2.7122	1.2886	0.0015	0.0002	0.2778	0.722	0.0042	5.0065
ts613-gt6-plag1-3	61.115	24.799	0.03	0	5.964	8.37	0.063	100.341	2.7065	1.2945	0.0011	0	0.283	0.7187	0.0035	5.0074
ts613-gt6-plag1-4	61.191	24.732	0.07	0	5.737	8.38	0.074	100.184	2.7123	1.2921	0.0026	0	0.2725	0.7202	0.0042	5.004
ts613-gt6-plag2-1	61.443	24.735	0.033	0.011	5.707	8.484	0.056	100.469	2.7151	1.2883	0.0012	0.0007	0.2702	0.7269	0.0031	5.0055
ts613-gt6-plag2-2	61.035	24.772	0.051	0.006	5.748	8.313	0.069	99.994	2.7099	1.2964	0.0019	0.0004	0.2734	0.7157	0.0039	5.0016
ts613-gt6-plag2-3	61.064	24.937	0.051	0	5.806	8.318	0.076	100.252	2.705	1.3021	0.0019	0	0.2756	0.7144	0.0043	5.0034
ts613-gt6-plag2-4	61.242	25.175	0.121	0.005	5.894	8.246	0.053	100.736	2.7002	1.3083	0.0045	0.0003	0.2784	0.7049	0.003	4.9997
ts613-gt6-plag3-1	61.114	24.755	0.031	0.007	5.883	8.448	0.063	100.301	2.7076	1.2928	0.0011	0.0005	0.2793	0.7257	0.0036	5.0107
ts613-gt6-plag3-2	61.337	24.82	0.054	0.004	5.717	8.476	0.097	100.505	2.7108	1.293	0.002	0.0002	0.2707	0.7264	0.0055	5.0087
ts613-gt6-plag3-3	61.359	24.895	0.062	0.001	5.761	8.376	0.104	100.558	2.7098	1.2959	0.0023	0.0001	0.2726	0.7173	0.0058	5.0039
ts613-gt6-plag3-4	61.457	24.584	0.023	0.005	5.663	8.554	0.064	100.35	2.7192	1.2821	0.0009	0.0003	0.2685	0.7339	0.0036	5.0085
ts613-gt6-plag4-1	61.281	24.689	0.026	0	5.771	8.491	0.041	100.299	2.7134	1.2885	0.001	0	0.2738	0.729	0.0023	5.008
ts613-gt6-plag4-2	61.34	24.691	0.036	0.002	5.646	8.331	0.08	100.126	2.718	1.2896	0.0013	0.0001	0.2681	0.7158	0.0045	4.9974
ts613-gt6-plag4-3	61.23	24.754	0.053	0	5.693	8.592	0.043	100.365	2.7104	1.2916	0.002	0	0.27	0.7374	0.0024	5.0139
ts613-gt6-plag4-4	60.839	24.95	0.059	0.014	5.955	8.274	0.079	100.17	2.6993	1.3048	0.0022	0.0009	0.2831	0.7118	0.0045	5.0067
ts388-gt8-plag1-1	61.545	24.592	0.206	0.01	5.573	8.581	0.07	100.577	2.7188	1.2805	0.0076	0.0006	0.2638	0.735	0.0039	5.0103
ts388-gt8-plag1-2	62.232	23.988	0.169	0	4.888	9.059	0.056	100.392	2.7495	1.2492	0.0062	0	0.2314	0.776	0.0031	5.0155
ts388-gt8-plag1-3	62.102	24.042	0.135	0.001	5.11	8.735	0.054	100.179	2.7478	1.2539	0.005	0	0.2423	0.7495	0.0031	5.0017
ts388-gt8-plag1-4	61.193	24.554	0.106	0	5.648	8.593	0.069	100.163	2.715	1.2841	0.0039	0	0.2685	0.7392	0.0039	5.0147
ts388-gt8-plag1-5	61.188	24.513	0.2	0	5.636	8.461	0.059	100.057	2.717	1.283	0.0074	0	0.2681	0.7285	0.0033	5.0073
ts388-gt8-plag1-6	61.778	24.139	0.158	0	5.111	8.837	0.082	100.105	2.7386	1.2613	0.0059	0	0.2428	0.7596	0.0047	5.0129
ts388-gt8-plag2-1	60.95	24.444	0.042	0	5.679	8.552	0.064	99.731	2.7154	1.2836	0.0016	0	0.2711	0.7388	0.0036	5.0142
ts388-gt8-plag2-2	61.433	24.617	0.044	0.003	5.673	8.466	0.05	100.286	2.719	1.2842	0.0016	0.0002	0.2691	0.7266	0.0028	5.0036
ts388-gt8-plag2-3	62.724	23.811	0.089	0	4.719	9.109	0.066	100.518	2.7639	1.2367	0.0033	0	0.2228	0.7783	0.0037	5.0087
ts388-gt8-plag2-4	62.242	23.768	0.065	0.019	4.616	9.115	0.096	99.921	2.7597	1.2421	0.0024	0.0013	0.2193	0.7836	0.0054	5.0139
ts388-gt8-plag2-5	61.334	24.64	0.103	0	5.515	8.631	0.099	100.322	2.716	1.2861	0.0038	0	0.2617	0.7411	0.0056	5.0143
ts388-gt8-plag2-6	61.24	24.593	0.062	0.001	5.586	8.582	0.064	100.128	2.7163	1.2858	0.0023	0.0001	0.2655	0.7381	0.0036	5.0117
ts388-gt8-plag3-1	61.929	24.145	0.047	0.009	5.009	8.895	0.068	100.102	2.7427	1.2604	0.0017	0.0006	0.2377	0.7638	0.0039	5.0108
ts388-gt8-plag3-2	61.796	23.897	0.021	0	5.148	8.785	0.063	99.71	2.7475	1.2524	0.0008	0	0.2452	0.7573	0.0036	5.0068
ts388-gt8-plag3-3	61.152	24.491	0.028	0.01	5.686	8.403	0.071	99.841	2.7189	1.2835	0.001	0.0007	0.2709	0.7245	0.004	5.0036
ts388-gt8-plag3-4	61.822	24.187	0.053	0.003	5.194	8.783	0.063	100.105	2.7388	1.263	0.002	0.0002	0.2466	0.7544	0.0036	5.0087
ts388-gt8-plag4-1	61.04	24.602	0.155	0.034	5.655	8.541	0.133	100.16	2.7101	1.2875	0.0057	0.0023	0.269	0.7353	0.0075	5.0174
ts388-gt8-plag4-2	61.284	24.707	0.095	0	5.669	8.672	0.06	100.487	2.7109	1.2882	0.0035	0	0.2687	0.7439	0.0034	5.0187
ts388-gt8-plag4-3	61.177	24.739	0.064	0.008	5.626	8.47	0.05	100.134	2.7125	1.2929	0.0024	0.0006	0.2673	0.7282	0.0028	5.0068
ts388-gt8-plag4-4	61.292	24.481	0.03	0	5.369	8.607	0.08	99.859	2.7235	1.2822	0.0011	0	0.2556	0.7415	0.0045	5.0085
ts287-pl1-1	57.394	26.597	0.147	0.005	7.976	7.363	0.066	99.548	2.5843	1.4116	0.0055	0.0003	0.3848	0.6428	0.0038	5.0332
ts287-pl1-2	57.532	26.172	0.109	0.001	7.669	7.488	0.083	99.054	2.6009	1.3946	0.0041	0	0.3715	0.6564	0.0048	5.0324
ts287-pl1-3	57.688	26.403	0.145	0.005	7.698	7.517	0.089	99.545	2.5959	1.4004	0.0055	0.0003	0.3712	0.6559	0.0051	5.0344
ts287-pl2-1	57.475	26.365	0.147	0	7.86	7.174	0.089	99.11	2.5959	1.4036	0.0056	0	0.3804	0.6283	0.0051	5.019
ts287-pl2-2	57.352	26.626	0.166	0	8.083	7.067	0.06	99.354	2.5853	1.4147	0.0063	0	0.3904	0.6177	0.0035	5.018
ts287-pl2-3	57.937	26.589	0.126	0	8.063	7.259	0.089	100.063	2.5934	1.4028	0.0047	0	0.3867	0.6301	0.0051	5.0229
ts287-pl3-1	58.426	26.332	0.165	0	7.477	7.526	0.063	99.989	2.6127	1.388	0.0062	0	0.3583	0.6526	0.0036	5.0215

Appendix 1 Mineral Chemistry

Plagioclase Chemistry

Weight percent oxide									Cation ratio							
Analysis	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Total	Si	Al	Fe	Mg	Ca	Na	K	Total
ts287-pl3-2	57.75	26.33	0.159	0	7.811	7.295	0.095	99.44	2.6001	1.3973	0.006	0	0.3768	0.6369	0.0055	5.0227
ts287-pl3-3	58.533	25.863	0.161	0.02	7.355	7.73	0.068	99.73	2.6251	1.3672	0.006	0.0013	0.3535	0.6723	0.0039	5.0294
ts287-pl4-1cnt-	55.569	24.918	1.709	0.004	7.325	7.273	0.082	96.88	2.5909	1.3694	0.0666	0.0002	0.3659	0.6575	0.0049	5.0554
ts287-pl4-1cnt-t2	54.241	26.942	0.504	0.103	6.483	6.297	1.322	95.892	2.5438	1.4893	0.0198	0.0072	0.3258	0.5726	0.0791	5.0377
ts287-pl4-1cnt-t3	57.49	26.03	0.185	0	7.434	7.499	0.095	98.733	2.6065	1.391	0.007	0	0.3612	0.6592	0.0055	5.0304
ts397-pl1-1	45.061	35.304	0.044	0	18.438	1.111	0.038	99.996	2.0785	1.9195	0.0017	0	0.9113	0.0993	0.0022	5.0126
ts397-pl1-2	45.336	35.5	0.016	0.009	18.385	1.144	0.009	100.399	2.0811	1.9207	0.0006	0.0006	0.9043	0.1018	0.0005	5.0096
ts397-pl1-3	45.42	35.244	0.034	0.009	18.362	1.206	0.043	100.318	2.0875	1.9092	0.0013	0.0006	0.9042	0.1075	0.0025	5.0129
ts397-pl2-1	45.238	34.978	0.158	0.096	16.724	1.023	0.819	99.036	2.1037	1.9173	0.0061	0.0066	0.8334	0.0923	0.0486	5.008
ts397-pl2-2	40.226	37.08	0.14	0.043	16.682	0.921	0.023	95.115	1.9506	2.1194	0.0057	0.0031	0.8668	0.0866	0.0015	5.0338
ts397-pl2-3	45.389	35.271	0.031	0	18.534	1.119	0.032	100.376	2.0853	1.91	0.0012	0	0.9124	0.0997	0.0019	5.0106
ts397-pl3-1	45.232	35.183	0.051	0.009	18.219	1.216	0.02	99.93	2.0864	1.9128	0.002	0.0006	0.9005	0.1087	0.0012	5.0122
ts397-pl3-2dark	43.64	34.165	0.206	0.002	17.832	1.072	0.035	96.952	2.0777	1.9173	0.0082	0.0001	0.9097	0.099	0.0021	5.0141
ts397-pl3-3	45.466	35.294	0.021	0	18.439	1.252	0.022	100.494	2.0864	1.909	0.0008	0	0.9066	0.1114	0.0013	5.0156
2336b-gt1-pl1-1	64.174	23.235	0.339	0.008	3.705	9.871	0.053	101.385	2.8009	1.1953	0.0124	0.0005	0.1733	0.8353	0.0029	5.0206
2336b-gt1-pl1-2	63.818	23.349	0.103	0	3.71	9.699	0.083	100.762	2.7985	1.2068	0.0038	0	0.1743	0.8247	0.0047	5.0129
2336b-gt1-pl1-3	64.172	23.065	0.038	0	3.798	9.826	0.064	100.963	2.8085	1.1898	0.0014	0	0.1781	0.8339	0.0035	5.0153
2336b-gt1-pl1-4	64.168	22.875	0.135	0	3.584	9.818	0.061	100.641	2.8161	1.1833	0.0049	0	0.1685	0.8355	0.0034	5.0117
2336b-gt1-pl2-1	63.694	23.166	0.03	0	3.771	9.586	0.071	100.318	2.8036	1.2019	0.0011	0	0.1779	0.8181	0.004	5.0066
2336b-gt1-pl2-2	63.753	23.111	0.049	0	3.643	9.601	0.081	100.238	2.8074	1.1996	0.0018	0	0.1719	0.8198	0.0045	5.0051
2336b-gt1-pl2-3	63.939	23.232	0.033	0	3.832	9.601	0.064	100.701	2.8038	1.2008	0.0012	0	0.18	0.8164	0.0036	5.0058
2336b-gt1-pl3-1	63.955	22.694	0.014	0	2.831	9.887	0.22	99.601	2.8298	1.1835	0.0005	0	0.1342	0.8482	0.0124	5.0087
2336b-gt1-pl3-2	64.058	22.793	0.027	0.003	3.45	9.83	0.076	100.237	2.8201	1.1828	0.001	0.0002	0.1627	0.8391	0.0043	5.0103
2336b-gt1-pl3-3	63.735	23.299	0.03	0.004	3.841	9.695	0.073	100.677	2.7976	1.2054	0.0011	0.0003	0.1807	0.8251	0.0041	5.0143
2336b-gt2-pl1-1	63.953	23.094	0.018	0	3.702	9.457	0.06	100.284	2.8123	1.197	0.0007	0	0.1744	0.8064	0.0034	4.9943
2336b-gt2-pl1-2	63.809	23.029	0	0	3.662	9.735	0.067	100.302	2.8088	1.1949	0	0	0.1727	0.8309	0.0037	5.011
2336b-gt2-pl1-3	64.122	23.033	0.026	0	3.613	9.635	0.043	100.472	2.815	1.1919	0.0009	0	0.1699	0.8201	0.0024	5.0003
2336b-gt2-pl2-1	63.795	23.029	0.033	0.006	3.784	9.622	0.069	100.338	2.8077	1.1947	0.0012	0.0004	0.1784	0.8211	0.0039	5.0075
2336b-gt2-pl2-2	63.615	23.082	0.014	0	3.687	9.618	0.068	100.084	2.806	1.2	0.0005	0	0.1743	0.8226	0.0038	5.0073
2336b-gt2-pl2-3	63.924	23.047	0.074	0.03	3.641	9.806	0.085	100.607	2.8073	1.193	0.0027	0.0019	0.1713	0.835	0.0048	5.016
2336b-gt2-pl3-1	45.745	30.458	4.51	5.067	0.034	0.09	10.15	96.06	2.2415	1.7591	0.1848	0.3701	0.0018	0.0085	0.6349	5.2007
2336b-gt2-pl3-2	49.845	27.969	4.837	3.371	0.186	0.08	9.9	96.188	2.4196	1.6003	0.1964	0.2439	0.0097	0.0075	0.6131	5.0905
2336b-gt2-pl3-3	50.093	28.253	4.513	3.331	0.157	0.079	9.924	96.35	2.4221	1.6102	0.1825	0.2401	0.0081	0.0074	0.6122	5.0827
2336b-gt3-pl1-1	63.311	23.27	0.031	0	3.708	9.812	0.079	100.211	2.7932	1.2101	0.0011	0	0.1753	0.8394	0.0045	5.0237
2336b-gt3-pl1-2	63.608	22.944	0.002	0	3.679	10.004	0.066	100.503	2.8068	1.1896	0.0001	0	0.1734	0.8533	0.0037	5.0269
2336b-gt3-pl1-3	63.559	23.261	0	0.001	3.729	9.89	0.087	100.527	2.7956	1.2059	0	0.0001	0.1757	0.8435	0.0049	5.0257
2336b-gt3-pl2-1	63.607	23.241	0.016	0.008	3.846	9.722	0.069	100.509	2.7971	1.2047	0.0006	0.0005	0.1812	0.829	0.0039	5.0171
2336b-gt3-pl2-2	64.069	23.253	0.026	0	3.763	9.697	0.099	100.907	2.8044	1.1997	0.001	0	0.1765	0.823	0.0055	5.0101
2336b-gt3-pl2-3	63.714	23.198	0.006	0	3.822	9.552	0.077	100.369	2.8029	1.2029	0.0002	0	0.1802	0.8148	0.0043	5.0054
2336b-gt3-pl3-1	63.623	23.12	0	0	3.708	9.648	0.09	100.189	2.8042	1.2011	0	0	0.1751	0.8246	0.0051	5.0101
2336b-gt3-pl3-2	64.183	23.048	0	0	3.515	9.868	0.102	100.716	2.8133	1.1908	0	0	0.1651	0.8387	0.0057	5.0137
2336b-gt3-pl3-3	63.654	22.986	0.024	0	3.78	9.632	0.088	100.164	2.807	1.1948	0.0009	0	0.1786	0.8236	0.0049	5.0098
0383-gt1-plag1-1	61.236	25.347	0.24	0.004	6.256	8.288	0.053	101.424	2.6878	1.3113	0.0088	0.0003	0.2942	0.7054	0.0029	5.0107
0383-gt1-plag1-2	61.169	25.208	0.127	0	6.272	8.481	0.061	101.318	2.6888	1.3061	0.0047	0	0.2954	0.7229	0.0034	5.0214
0383-gt1-plag1-3	61.201	25.311	0.062	0	6.241	8.512	0.051	101.378	2.6876	1.3101	0.0023	0	0.2937	0.7248	0.0028	5.0214
0383-gt1-plag2-1	61.051	25.173	0.032	0.011	6.239	8.211	0.056	100.773	2.6934	1.309	0.0012	0.0007	0.2949	0.7024	0.0031	5.0047
0383-gt1-plag2-2	61.462	25.246	0.042	0	6.189	8.383	0.042	101.364	2.696	1.3053	0.0015	0	0.2909	0.713	0.0023	5.009
0383-gt1-plag2-3	60.979	25.414	0.04	0	6.522	8.263	0.043	101.261	2.6811	1.3171	0.0015	0	0.3073	0.7045	0.0024	5.0139
0383-gt1-plag3-1	60.853	25.332	0.193	0.004	6.369	8.257	0.069	101.097	2.6814	1.3157	0.0071	0.0002	0.3017	0.7054	0.0039	5.0155
0383-gt1-plag3-2	61.558	24.945	0.108	0	5.724	8.651	0.071	101.057	2.7077	1.2933	0.004	0	0.2698	0.7378	0.004	5.0167
0383-gt1-plag3-3	61.083	25.442	0.092	0	6.307	8.354	0.048	101.326	2.6833	1.3174	0.0034	0	0.2969	0.7116	0.0027	5.0153
0383-gt2-plag1-1	60.889	25.283	0.245	0	6.195	8.256	0.044	100.912	2.6859	1.3146	0.009	0	0.2928	0.7062	0.0025	5.0111
0383-gt2-plag1-2	60.911	25.366	0.133	0	6.367	8.297	0.042	101.116	2.6822	1.3166	0.0049	0	0.3004	0.7084	0.0024	5.0149
0383-gt2-plag1-3	60.62	25.52	0.19	0.006	6.499	8.287	0.054	101.176	2.671	1.3254	0.007	0.0004	0.3068	0.7081	0.0031	5.0219
0383-gt2-plag2-1	61.155	25.203	0.212	0	6.3	8.436	0.066	101.372	2.6879	1.3056	0.0078	0	0.2967	0.7189	0.0037	5.0207
0383-gt2-plag2-2	60.93	25.49	0.127	0	6.256	8.25	0.051	101.104	2.6816	1.3223	0.0047	0	0.295	0.7041	0.0029	5.0107
0383-gt2-plag2-3	60.547	25.632	0.092	0.002	6.54	8.313	0.026	101.152	2.6676	1.3311	0.0034	0.0002	0.3087	0.7102	0.0014	5.0227
0383-gt2-plag3-1	61.054	25.422	0.031	0.009	6.196	8.422	0.053	101.187	2.6847	1.3176	0.0011	0.0006	0.2919	0.7181	0.003	5.0171
0383-gt2-plag3-2	61.293	25.276	0.028	0	6.311	8.293	0.05	101.251	2.6922	1.3086	0.001	0	0.297	0.7063	0.0028	5.0079
0383-gt2-plag3-3	61.026	25.269	0.037	0	6.409	8.211	0.053	101.005	2.6881	1.3119	0.0013	0	0.3025	0.7013	0.003	5.0082
0293-gt1-plag1-1	59.249	26.434	0.193	0	7.724	7.48	0.064	101.144	2.6192	1.3774	0.0071	0	0.3659	0.6412	0.0036	5.0145
0293-gt1-plag1-2	59.25	26.458	0.15	0.007	7.683	7.508	0.066	101.122	2.6192	1.3786	0.0055	0.0005	0.3639	0.6435	0.0037	5.015
0293-gt1-plag1-3	58.989	26.408	0.09	0	7.675	7.466	0.069	100.697	2.6181	1.3815	0.0033	0	0.365	0.6426	0.0039	5.0144
0293-gt1-plag2-1	59.394	25.774	0.088	0.036	7.25	7.683	0.079	100.304	2.6434	1.3521	0.0033	0.0024	0.3457	0.663	0.0045	5.0144
0293-gt1-plag2-2	59.291	26.301	0.051	0.002	7.505	7.559	0.061	100.77	2.6273	1.3737	0.0019	0.0001	0.3564	0.6494	0.0035	5.0124
0293-gt1-plag2-3	59.77	26.171	0.118	0	7.498	7.528	0.081	101.166	2.6375	1.3612	0.0043	0	0.3545	0.6441	0.0046	5.0062
0293-gt1-plag3-1	59.02	26.131	0.066	0.011	7.512	7.632	0.087	100.459	2.6258	1.3703	0.0024	0.0007	0.3581	0.6584	0.0049	5.0206
0293-gt1-plag3-2	58.854	26.445	0.093	0	7.871	7.404	0.078	100.745	2.6128	1.3838	0.0034	0	0.3744	0.6373	0.0044	5.0161
0293-gt1-plag3-3	59.182	26.334	0.094	0	7.649	7.421	0.065	100.745	2.624	1.3762	0.0035	0	0.3634	0.638	0.0037	5.0089
0293-gt2-plag1-1	59.304	26.369	0.378	0	7.547	7.601	0.049	101.248	2.6207	1.3735	0.014	0	0.3574	0.6513	0.0027	5.0196
0293-gt2-plag1-2	59.096	26.666	0.255	0	7.807	7.422	0.039	101.285	2.61	1.3882	0.0094	0	0.3694	0.6356	0.0022	5.0148
0293-gt2-plag1-3	58.946	26.292	0.203	0.008	7.643	7.543	0.052	100.687	2.6184	1.3766	0.0075	0.0005	0.3638	0.6497	0.003	5.0195

Appendix 1 Mineral Chemistry

Plagioclase Chemistry

Weight percent oxide									Cation ratio							
Analysis	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Total	Si	Al	Fe	Mg	Ca	Na	K	Total
0293-gt2-plag2-1	59.068	26.746	0.171	0.005	7.66	7.361	0.062	101.073	2.6114	1.3937	0.0063	0.0003	0.3628	0.631	0.0035	5.009
0293-gt2-plag2-2	59.231	26.602	0.135	0	7.697	7.43	0.07	101.165	2.6165	1.3851	0.005	0	0.3643	0.6364	0.0039	5.0113
0293-gt2-plag2-3	60.492	25.72	0.187	0	6.522	8.127	0.072	101.12	2.6659	1.336	0.0069	0	0.308	0.6945	0.0041	5.0155
0293-gt2-plag3-1	59.427	25.831	0.175	0.001	7.587	7.48	0.055	100.556	2.6399	1.3525	0.0065	0.0001	0.3611	0.6443	0.0031	5.0075
0293-gt2-plag3-2	59.254	25.925	0.223	0	7.141	7.724	0.074	100.341	2.6376	1.3602	0.0083	0	0.3406	0.6667	0.0042	5.0177
0293-gt2-plag3-3	59.358	26.25	0.175	0.004	7.382	7.447	0.048	100.664	2.6317	1.3718	0.0065	0.0002	0.3507	0.6402	0.0027	5.0038
0293-gt3-plag1-1	59.428	26.183	0.28	0.007	7.605	7.502	0.054	101.059	2.6288	1.3652	0.0103	0.0005	0.3605	0.6435	0.003	5.0118
0293-gt3-plag1-2	60.48	25.24	0.186	0.001	6.526	7.988	0.073	100.494	2.6801	1.3184	0.0069	0.0001	0.3099	0.6864	0.0041	5.0059
0293-gt3-plag1-3	59.032	26.263	0.119	0.003	7.708	7.32	0.077	100.522	2.6235	1.3758	0.0044	0.0002	0.3671	0.6308	0.0044	5.0062
0293-gt3-plag2-1	59.664	26.192	0.116	0.008	7.41	7.472	0.048	100.91	2.6377	1.3648	0.0043	0.0005	0.351	0.6405	0.0027	5.0016
0293-gt3-plag2-2	59.388	26.556	0.113	0.017	7.738	7.493	0.065	101.37	2.6184	1.3801	0.0042	0.0011	0.3655	0.6406	0.0036	5.0135
0293-gt3-plag2-3	59.465	26.54	0.086	0	7.677	7.523	0.065	101.356	2.6213	1.3789	0.0032	0	0.3626	0.643	0.0036	5.0127
0293-gt3-plag3-1	59.158	26.441	0.121	0	7.805	7.469	0.081	101.075	2.6173	1.3789	0.0045	0	0.37	0.6408	0.0046	5.0161
0293-gt3-plag3-2	58.777	26.406	0.117	0	7.487	7.561	0.062	100.41	2.6162	1.3854	0.0043	0	0.3571	0.6526	0.0035	5.0192
0293-gt3-plag3-3	60.439	25.371	0.096	0	6.542	8.063	0.076	100.587	2.6759	1.324	0.0035	0	0.3103	0.6922	0.0043	5.0103
0174-gt3-plag1-1	59.433	26.152	0.26	0	7.531	7.833	0.055	101.264	2.6266	1.3623	0.0096	0	0.3566	0.6712	0.0031	5.0294
0174-gt3-plag1-2	59.325	26.287	0.197	0	7.696	7.682	0.055	101.242	2.6218	1.3693	0.0073	0	0.3644	0.6583	0.0031	5.0242
0174-gt3-plag1-3	59.764	26.222	0.138	0.004	7.529	7.695	0.07	101.422	2.633	1.3617	0.0051	0.0003	0.3554	0.6574	0.0039	5.0168
0174-gt3-plag2-1	59.86	26.288	0.122	0	7.429	7.687	0.073	101.459	2.6347	1.3638	0.0045	0	0.3504	0.656	0.0041	5.0136
0174-gt3-plag2-2	60.082	26.196	0.137	0.002	7.383	7.766	0.068	101.634	2.6398	1.3566	0.005	0.0002	0.3476	0.6616	0.0038	5.0146
0174-gt3-plag2-3	59.702	26.16	0.176	0	7.341	7.631	0.051	101.061	2.6373	1.3621	0.0065	0	0.3475	0.6536	0.0028	5.0099
0174-gt3-plag3-1	59.545	26.145	0.135	0.011	7.351	7.737	0.051	100.975	2.6339	1.3632	0.005	0.0007	0.3484	0.6636	0.0029	5.0178
0174-gt3-plag3-2	59.515	25.918	0.051	0.001	7.324	7.662	0.078	100.549	2.6418	1.3561	0.0019	0.0001	0.3483	0.6595	0.0044	5.0121
0174-gt3-plag3-3	59.649	25.82	0.026	0.003	7.358	7.687	0.061	100.604	2.6459	1.35	0.0009	0.0002	0.3497	0.6611	0.0035	5.0114
0174-gt2-plag1-1	59.28	26.585	0.377	0.007	7.712	7.508	0.071	101.54	2.6132	1.3814	0.0139	0.0005	0.3643	0.6417	0.004	5.0191
0174-gt2-plag1-2	59.125	26.333	0.079	0	7.713	7.471	0.075	100.796	2.6215	1.3762	0.0029	0	0.3664	0.6423	0.0043	5.0136
0174-gt2-plag1-3	59.345	26.423	0.093	0.008	7.612	7.474	0.074	101.029	2.6237	1.377	0.0034	0.0005	0.3606	0.6407	0.0042	5.0101
0174-gt2-plag2-1	60.045	26.194	0.156	0.003	7.345	7.693	0.057	101.493	2.6408	1.3579	0.0057	0.0002	0.3461	0.6561	0.0032	5.0101
0174-gt2-plag2-2	59.632	26.351	0.064	0	7.556	7.572	0.068	101.243	2.63	1.3699	0.0024	0	0.3571	0.6476	0.0038	5.0108
0174-gt2-plag2-3	58.985	26.355	0.043	0.009	7.728	7.448	0.067	100.635	2.6192	1.3794	0.0016	0.0006	0.3677	0.6413	0.0038	5.0136
0174-gt2-plag3-1	59.175	26.302	0.11	0.006	7.587	7.704	0.067	100.951	2.6213	1.3733	0.0041	0.0004	0.3601	0.6617	0.0038	5.0247
0174-gt2-plag3-2	59.657	26.027	0.053	0	7.258	7.757	0.073	100.825	2.6409	1.358	0.002	0	0.3443	0.6659	0.0041	5.0153
0174-gt2-plag3-3	59.309	26.292	0.026	0	7.663	7.586	0.076	100.952	2.6252	1.3717	0.0009	0	0.3634	0.651	0.0043	5.0166
0220-gt1-plag1-1	63.069	23.746	0.334	0	4.607	9.341	0.07	101.167	2.7656	1.2273	0.0122	0	0.2165	0.7942	0.0039	5.0198
0220-gt1-plag1-2	63.424	23.549	0.072	0.004	4.356	9.353	0.073	100.831	2.7828	1.2179	0.0026	0.0002	0.2048	0.7957	0.0041	5.0082
0220-gt1-plag1-3	63.485	23.346	0.114	0	4.082	9.541	0.096	100.664	2.7901	1.2094	0.0042	0	0.1922	0.813	0.0054	5.0144
0220-gt1-plag2-1	63.155	23.373	0.062	0.005	3.894	9.489	0.054	100.032	2.7898	1.217	0.0023	0.0003	0.1843	0.8127	0.0031	5.0096
0220-gt1-plag2-2	63.456	23.475	0.07	0	4.03	9.643	0.065	100.739	2.7865	1.215	0.0026	0	0.1896	0.821	0.0036	5.0184
0220-gt1-plag2-3	63.475	23.417	0.066	0	4.373	9.376	0.075	100.782	2.7866	1.2117	0.0024	0	0.2057	0.7981	0.0042	5.0087
0220-gt1-plag3-1	57.295	21.634	1.443	0.128	3.792	8.087	0.777	93.156	2.7507	1.2242	0.0579	0.0092	0.1951	0.7528	0.0476	5.0375
0220-gt1-plag3-2	63.864	23.32	0.096	0.004	3.943	9.789	0.067	101.083	2.7949	1.2029	0.0035	0.0003	0.1849	0.8307	0.0038	5.021
0220-gt1-plag3-3	64.356	22.656	0.096	0	3.439	9.898	0.051	100.496	2.8263	1.1728	0.0035	0	0.1618	0.8428	0.0029	5.0101
0220-gt2-plag1-1	62.947	23.452	0.113	0.006	4.357	9.334	0.067	100.276	2.7788	1.2203	0.0042	0.0004	0.2061	0.799	0.0038	5.0127
0220-gt2-plag1-2	63.441	23.117	0.068	0.002	3.919	9.366	0.078	99.991	2.8018	1.2034	0.0025	0.0002	0.1855	0.8021	0.0044	5
0220-gt2-plag1-3	63.408	23.438	0.021	0	4.132	9.408	0.069	100.476	2.7892	1.2152	0.0008	0	0.1948	0.8025	0.0039	5.0064
0220-gt2-plag2-1	63.522	23.508	0.056	0	4.114	9.398	0.075	100.673	2.7888	1.2165	0.002	0	0.1935	0.8	0.0042	5.0051
0220-gt2-plag2-2	63.263	23.183	0.042	0.005	4.059	9.548	0.075	100.175	2.7929	1.2063	0.0016	0.0003	0.192	0.8173	0.0042	5.0147
0220-gt2-plag2-3	63.318	23.189	0.072	0	4.118	9.442	0.063	100.202	2.7939	1.206	0.0027	0	0.1947	0.8079	0.0036	5.0089
0220-gt2-plag3-1	62.385	23.613	0.09	0	4.445	9.317	0.044	99.894	2.7663	1.2341	0.0033	0	0.2112	0.801	0.0025	5.0185
0220-gt2-plag3-2	63.042	23.209	0.035	0	3.938	9.514	0.09	99.828	2.7918	1.2115	0.0013	0	0.1869	0.817	0.0051	5.0137
0220-gt2-plag3-3	62.941	23.254	0.1	0	4.266	9.444	0.068	100.073	2.7842	1.2125	0.0037	0	0.2022	0.81	0.0038	5.0164
0224-gt1-plag1-1	61.566	24.361	0.159	0	5.371	8.641	0.087	100.185	2.7283	1.2725	0.0059	0	0.255	0.7425	0.0049	5.0092
0224-gt1-plag1-2	61.536	24.537	0.112	0.05	5.411	8.712	0.121	100.479	2.7207	1.2787	0.0042	0.0033	0.2563	0.7468	0.0068	5.0168
0224-gt1-plag1-3	61.383	24.488	0.061	0	5.432	8.675	0.081	100.12	2.7222	1.28	0.0023	0	0.2581	0.7459	0.0046	5.0132
0224-gt1-plag2-1	61.486	24.474	0.033	0.005	5.563	8.801	0.08	100.442	2.7203	1.2763	0.0012	0.0003	0.2637	0.755	0.0045	5.0213
0224-gt1-plag2-2	62.199	24.212	0.03	0	5.135	8.813	0.106	100.495	2.7439	1.259	0.0011	0	0.2427	0.7539	0.006	5.0066
0224-gt1-plag2-3	61.594	24.439	0.098	0.009	5.488	8.811	0.102	100.541	2.7227	1.2733	0.0036	0.0006	0.26	0.7552	0.0058	5.0213
0224-gt1-plag3-1	61.484	24.28	0.013	0	5.373	8.65	0.08	99.88	2.7311	1.2712	0.0005	0	0.2557	0.745	0.0046	5.0082
0224-gt1-plag3-2	61.759	24.161	0.049	0	5.396	8.662	0.13	100.157	2.7367	1.2619	0.0018	0	0.2562	0.7442	0.0073	5.0081
0224-gt1-plag3-3	61.37	24.431	0.012	0	5.428	8.651	0.086	99.978	2.7245	1.2784	0.0004	0	0.2582	0.7447	0.0049	5.0112
4085pl1-1	61.72	23.935	0.202	0	4.879	8.685	0.087	99.508	4.1232	1.8847	0.0113	0	0.3492	1.125	0.0074	7.5008
4085pl1-2	61.168	23.938	0.106	0	4.893	8.77	0.09	98.965	4.111	1.8963	0.006	0	0.3523	1.1428	0.0078	7.5163
4085pl2-1	61.485	23.754	0.029	0	4.984	8.796	0.077	99.125	4.124	1.8779	0.0016	0	0.3582	1.144	0.0066	7.5124
4085pl2-2	61.662	23.858	0.052	0	4.899	8.761	0.092	99.324	4.1257	1.8815	0.0029	0	0.3512	1.1366	0.0079	7.5059
4085pl2-3	61.815	23.909	0.037	0	4.855	8.791	0.118	99.525	4.1271	1.8815	0.0021	0	0.3473	1.1381	0.0101	7.5063
4085pl3-1	61.39	24.007	0.053	0	4.994	8.434	0.054	98.932	4.1194	1.8988	0.003	0	0.3591	1.0974	0.0046	7.4823
4085pl3-2	60.966	24.014	0.037	0	4.917	8.584	0.062	98.58	4.1089	1.9077	0.0021	0	0.3551	1.1218	0.0053	7.501
4085pl3-3	61.126	23.893	0.05	0	5.013	8.319	0.042	98.443	4.1208	1.8986	0.0028	0	0.3621	1.0875	0.0036	7.4755
1026pl1-1	61.779	23.795	0.114	0	4.657	8.641	0.071	99.057	4.1385	1.8788	0.0064	0	0.3343	1.1223	0.006	7.4864
1026pl1-2	61.914	23.801	0.104	0.007	4.559	8.682	0.079	99.146	4.1423	1.8769	0.0058	0.0007	0.3268	1.1263	0.0067	7.4855
1026pl1-3	61.646	23.756	0.056	0	4.675	8.735	0.05	98.918	4.1361	1.8787	0.0032	0	0.3361	1.1364	0.0043	7.4949
1026pl2-1	61.407	23.907	0.076	0	4.814	8.687	0.053	98.944	4.1222	1.8916	0.0043	0	0.3463	1.1307	0.0045	7.4997

Appendix 1 Mineral Chemistry

Plagioclase Chemistry

Weight percent oxide									Cation ratio							
Analysis	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	Total	Si	Al	Fe	Mg	Ca	Na	K	Total
1026pl2-2	61.648	23.73	0.098	0.007	4.583	8.849	0.061	98.976	4.1358	1.8765	0.0055	0.0007	0.3294	1.1511	0.0052	7.5043
1026pl2-3	61.791	23.947	0.046	0.005	4.828	8.826	0.039	99.482	4.1258	1.8846	0.0026	0.0005	0.3454	1.1427	0.0033	7.505
1026pl3-1	61.805	23.993	0.199	0.008	4.73	8.788	0.045	99.568	4.1243	1.8872	0.0111	0.0008	0.3382	1.1371	0.0039	7.5027
1026pl3-2	61.939	23.89	0.074	0	4.805	8.555	0.063	99.325	4.1371	1.8808	0.0041	0	0.3439	1.108	0.0053	7.4792
1026pl3-3	61.528	23.774	0.093	0	4.796	8.834	0.078	99.103	4.1266	1.8795	0.0052	0	0.3447	1.1488	0.0066	7.5114
0032bpl1-1	60.928	24.323	0.295	0	5.327	8.367	0.077	99.317	4.0851	1.9222	0.0166	0	0.3827	1.0878	0.0066	7.501
0032bpl1-2	60.714	24.41	0.091	0	5.319	8.442	0.089	99.065	4.0793	1.9332	0.0051	0	0.3829	1.0998	0.0076	7.5079
0032bpl1-3	60.959	24.108	0.105	0.004	5.419	8.394	0.074	99.063	4.0952	1.909	0.0059	0.0004	0.39	1.0935	0.0063	7.5003
0032bpl2-1	60.909	24.3	0.057	0.01	5.372	8.328	0.071	99.047	4.0897	1.9231	0.0032	0.001	0.3865	1.0843	0.0061	7.494
0032bpl2-2	61.006	24.199	0.065	0.002	5.442	8.347	0.076	99.137	4.0937	1.9141	0.0036	0.0002	0.3913	1.0861	0.0065	7.4956
0032bpl2-3	60.812	24.486	0.064	0.014	5.499	8.332	0.069	99.276	4.0767	1.9348	0.0036	0.0014	0.395	1.0831	0.0059	7.5006
0032bpl3-1	60.726	24.366	0.106	0.005	5.484	8.288	0.056	99.031	4.0807	1.9299	0.0059	0.0005	0.3949	1.0799	0.0048	7.4966
0032bpl3-2	60.897	24.306	0.061	0.007	5.457	8.366	0.052	99.146	4.0866	1.9226	0.0034	0.0007	0.3924	1.0886	0.0044	7.4987
0032bpl3-3	60.771	24.184	0.029	0.007	5.556	8.35	0.096	98.993	4.0867	1.9169	0.0016	0.0007	0.4003	1.0888	0.0082	7.5033
2133plint1-1	58.463	25.757	0.113	0	7.536	7.509	0.048	99.426	3.9425	2.0473	0.0064	0	0.5445	0.9819	0.0042	7.5269
2133plint1-2	58.606	25.756	0.089	0	7.416	7.552	0.068	99.487	3.948	2.0451	0.005	0	0.5353	0.9865	0.0058	7.5258
2133plint2-1	58.752	25.744	0.17	0	7.572	7.343	0.063	99.644	3.9511	2.0407	0.0095	0	0.5457	0.9576	0.0054	7.5101
2133plint2-2	58.024	26.052	0.21	0	7.822	7.279	0.046	99.433	3.9172	2.073	0.0118	0	0.5658	0.9529	0.0039	7.5247
2133plint3-1	58.02	25.789	0.187	0	7.852	7.116	0.043	99.007	3.9306	2.0593	0.0106	0	0.57	0.9347	0.0037	7.509
2133pl1-1	58.401	25.319	0.182	0.075	7.219	7.066	0.206	98.468	3.9695	2.0285	0.0103	0.0076	0.5258	0.9312	0.0178	7.4908
2133pl1-2	57.951	25.59	0.043	0	7.637	7.228	0.039	98.488	3.9423	2.0519	0.0025	0	0.5567	0.9534	0.0034	7.5103
2133pl1-3	57.748	25.606	0.038	0	7.563	7.162	0.047	98.164	3.9401	2.0593	0.0022	0	0.5529	0.9475	0.0041	7.5061
2133pl2-1	58.045	25.52	0	0	7.715	7.047	0.067	98.394	3.9497	2.0468	0	0	0.5625	0.9297	0.0058	7.4945
2133pl2-2	58.01	26.253	0.003	0	7.524	7.117	0.062	98.969	3.9231	2.0927	0.0001	0	0.5452	0.9333	0.0053	7.4998
2133pl2-3	58.068	26.26	0	0	7.514	7.119	0.101	99.062	3.9239	2.0916	0	0	0.5441	0.9328	0.0087	7.5011
2133pl3-1	58.314	26.384	0.001	0	7.335	7.354	0.075	99.463	3.9244	2.0929	0	0	0.5289	0.9596	0.0064	7.5123
2133pl3-2	58.076	26.164	0.014	0	7.36	7.067	0.073	98.754	3.9327	2.0884	0.0008	0	0.534	0.9279	0.0063	7.4901
2133pl3-3	58.251	26.105	0.014	0	7.513	6.854	0.075	98.812	3.94	2.0813	0.0008	0	0.5445	0.8989	0.0065	7.472
1181pl1-1tch	58.478	26.182	0.152	0	7.728	7.056	0.105	99.701	3.9299	2.0739	0.0086	0	0.5565	0.9195	0.009	7.4975
1181pl1-2	58.36	25.966	0.049	0	7.507	6.953	0.12	98.955	3.9447	2.0688	0.0028	0	0.5437	0.9113	0.0104	7.4818
1181pl1-3	58.311	26.303	0.046	0	7.692	7.135	0.143	99.63	3.9219	2.0852	0.0026	0	0.5543	0.9305	0.0123	7.5069
1181pl2-1	58.567	25.928	0.035	0	7.444	7.246	0.122	99.342	3.9465	2.0593	0.002	0	0.5375	0.9467	0.0105	7.5025
1181pl2-2	59.155	25.472	0.082	0.044	6.753	7.326	0.267	99.099	3.9883	2.0242	0.0046	0.0044	0.4879	0.9578	0.0229	7.4901
1181pl2-3	58.433	25.948	0.024	0	7.326	6.919	0.169	98.819	3.952	2.0685	0.0014	0	0.5309	0.9073	0.0145	7.4746
1181pl3-1	58.368	26.092	0.011	0	7.378	7.212	0.137	99.198	3.938	2.0749	0.0006	0	0.5334	0.9434	0.0118	7.5022
1181pl3-2	58.625	26.081	0.025	0.004	7.37	7.143	0.18	99.428	3.945	2.0687	0.0014	0.0004	0.5314	0.9321	0.0155	7.4946
1181pl3-3	58.587	25.781	0.041	0.01	7.046	7.047	0.283	98.795	3.9637	2.0559	0.0023	0.0011	0.5108	0.9245	0.0244	7.4827
1047pl1-1tch	60.71	24.463	0.062	0.005	5.29	8.402	0.078	99.01	4.0791	1.9374	0.0035	0.0005	0.3809	1.0947	0.0067	7.5029
1047pl1-2	61.72	24.203	0.053	0	5.067	8.517	0.056	99.616	4.1147	1.9019	0.003	0	0.3619	1.101	0.0048	7.4873
1047pl1-3	61.881	23.996	0.034	0	4.883	8.624	0.088	99.506	4.1285	1.887	0.0019	0	0.3491	1.1156	0.0075	7.4897
1047pl2-1	61.806	23.823	0.034	0	4.762	8.412	0.087	98.924	4.1417	1.8817	0.0019	0	0.3419	1.0931	0.0074	7.4678
1047pl2-2	61.859	23.684	0.016	0	4.692	8.715	0.086	99.052	4.1438	1.87	0.0009	0	0.3368	1.132	0.0074	7.4909
1047pl2-3	62.096	23.607	0.067	0	4.624	8.679	0.081	99.154	4.1534	1.8612	0.0038	0	0.3314	1.1257	0.0069	7.4824
1047pl3-1	61.773	23.805	0.02	0.004	4.847	8.592	0.071	99.112	4.136	1.8787	0.0011	0.0004	0.3478	1.1155	0.0061	7.4857
1047pl3-2	61.959	23.547	0.032	0	4.476	8.653	0.078	98.745	4.1581	1.8626	0.0018	0	0.3219	1.126	0.0067	7.4771
1047pl3-3	61.783	23.724	0.042	0	4.592	8.745	0.081	98.967	4.142	1.8747	0.0023	0	0.3298	1.1368	0.0069	7.4925
1047pl1-1-1tch	61.171	24.346	0.238	0	5.023	8.538	0.045	99.361	4.0946	1.9209	0.0133	0	0.3602	1.1081	0.0038	7.5009
1047pl1-1-2	61.46	24.082	0.092	0	4.751	8.701	0.06	99.146	4.117	1.9014	0.0051	0	0.341	1.1302	0.0052	7.4999
1047pl1-1-3	61.777	23.52	0.077	0.001	4.728	8.872	0.103	99.078	4.1429	1.8592	0.0043	0.0001	0.3398	1.1537	0.0088	7.5089
1047pl1-2-1	61.455	23.567	0.021	0	4.675	8.865	0.081	98.664	4.1372	1.87	0.0012	0	0.3372	1.1572	0.007	7.5099
1047pl1-2-2	61.66	23.315	0.01	0	4.801	8.732	0.103	98.621	4.1516	1.8503	0.0005	0	0.3463	1.14	0.0088	7.4976
1047pl1-2-3	61.758	23.174	0.052	0	4.573	8.909	0.087	98.553	4.1606	1.8402	0.0029	0	0.3301	1.1637	0.0075	7.5051
1047pl1-3-1	61.852	23.405	0.009	0	4.677	8.83	0.128	98.901	4.1524	1.852	0.0005	0	0.3364	1.1494	0.011	7.5017
1047pl1-3-2	61.444	23.314	0.02	0.004	4.481	8.325	0.098	97.686	4.1641	1.8624	0.0011	0.0004	0.3254	1.094	0.0085	7.456
1047pl1-3-3	61.528	23.614	0.009	0	4.734	8.19	0.087	98.162	4.1507	1.8777	0.0005	0	0.3422	1.0713	0.0075	7.45
1107pl1-1	61.397	24.095	0.21	0	5.014	8.036	0.16	98.912	4.1198	1.9057	0.0118	0	0.3605	1.0455	0.0137	7.4571
1107pl1-2	61.706	24.13	0.172	0	4.811	8.382	0.206	99.407	4.1222	1.9	0.0096	0	0.3444	1.0857	0.0175	7.4795
1107pl1-3	61.887	23.976	0.093	0.001	4.814	8.1	0.197	99.068	4.14	1.8906	0.0052	0.0001	0.3451	1.0507	0.0168	7.4485
1107pl2-1	61.833	23.791	0.065	0.018	4.645	8.448	0.201	99.001	4.1428	1.8788	0.0036	0.0018	0.3335	1.0975	0.0172	7.4752
1107pl2-2	61.69	23.836	0.049	0.001	4.764	8.167	0.235	98.742	4.1417	1.8863	0.0028	0.0001	0.3427	1.0632	0.0201	7.457
1107pl2-3	61.196	23.829	0.113	0.015	4.68	8.505	0.215	98.553	4.1247	1.8931	0.0064	0.0015	0.338	1.1116	0.0185	7.4938
1107pl3-1	61.515	23.847	0.048	0.015	4.711	8.347	0.217	98.7	4.1346	1.8893	0.0027	0.0015	0.3393	1.0878	0.0186	7.4739
1107pl3-2	61.577	23.805	0.055	0.008	4.661	8.365	0.213	98.684	4.1387	1.8859	0.0031	0.0008	0.3356	1.0902	0.0183	7.4727
1107pl3-3	61.718	23.55	0.058	0.006	4.548	8.825	0.191	98.896	4.1449	1.8642	0.0033	0.0006	0.3273	1.1492	0.0164	7.5059

Appendix 1 Mineral Chemistry

Staurolite

	Weight percent oxide									Cation ration								
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	ZnO	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Zn	Total
4085grain1	26.961	0.672	53.988	12.672	0.287	1.725	0	0.569	96.874	1.9702	0.0369	4.6501	0.7744	0.0178	0.1879	0	0.0307	7.6681
4085grain2	26.448	0.674	54.441	12.801	0.309	1.572	0	0.517	96.762	1.9369	0.0371	4.6994	0.784	0.0192	0.1716	0	0.0279	7.6761
4085grain3	26.815	0.662	54.052	12.865	0.294	1.594	0.02	0.493	96.795	1.9625	0.0364	4.6629	0.7874	0.0182	0.1739	0.0016	0.0267	7.6696
4085grain4	27.255	0.59	53.88	12.78	0.299	1.672	0.001	0.458	96.935	1.989	0.0324	4.6347	0.78	0.0185	0.1819	0.0001	0.0247	7.6613
4085grain5	27.058	0.606	54.259	12.99	0.296	1.661	0	0.52	97.39	1.9686	0.0332	4.6531	0.7904	0.0182	0.1802	0	0.0279	7.6716
4085grain6	26.654	0.576	54.37	12.93	0.264	1.732	0.023	0.497	97.046	1.9466	0.0316	4.6803	0.7897	0.0163	0.1885	0.0018	0.0268	7.6817
4085grain7	26.895	0.676	54.485	12.776	0.25	1.76	0	0.544	97.386	1.9553	0.0369	4.6689	0.7768	0.0154	0.1908	0	0.0292	7.6734
4085grain8	27.138	0.797	54.274	12.91	0.282	1.782	0.015	0.574	97.772	1.9669	0.0434	4.6366	0.7826	0.0173	0.1926	0.0012	0.0307	7.6713
4085grain9	26.91	0.651	54.107	13.144	0.242	1.718	0.002	0.557	97.331	1.9614	0.0357	4.6485	0.8012	0.0149	0.1867	0.0002	0.03	7.6787
4085grain10	27.134	0.889	53.718	12.944	0.261	1.706	0.003	0.557	97.212	1.9783	0.0487	4.6166	0.7893	0.0161	0.1854	0.0002	0.03	7.6646

Cordierite

	Weight percent oxide										Cation ration									
Analysis	SiO_2	TiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Total	Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	Total
Comment																				
2133 1.1	48.334	N/A	32.75	6.303	0.073	9.349	0	0.274	0.028	97.111	4.9965	N/A	3.9904	0.5449	0.0064	1.4407	0	0.0548	0.0037	11.0375
2133 1.2	48.33	N/A	32.772	6.235	0.073	9.222	0.008	0.205	0.027	96.872	5.004	N/A	3.9995	0.5399	0.0064	1.4233	0.0008	0.0411	0.0035	11.0185
2133 1.3	48.514	N/A	32.981	6.251	0.067	9.256	0.01	0.233	0.026	97.338	4.9993	N/A	4.006	0.5387	0.0058	1.4218	0.0011	0.0465	0.0034	11.0226
2133 1.5	48.495	N/A	33.017	6.197	0.079	9.266	0.019	0.251	0	97.324	4.9969	N/A	4.0099	0.534	0.0069	1.4232	0.0021	0.0501	0	11.0231
2133 2.1	48.22	N/A	33.095	6.243	0.099	9.446	0.025	0.363	0.026	97.517	4.9673	N/A	4.0184	0.5378	0.0087	1.4506	0.0027	0.0725	0.0034	11.0615
2133 2.2	48.504	N/A	32.976	6.253	0.067	9.497	0	0.362	0.047	97.706	4.9851	N/A	3.9949	0.5375	0.0058	1.4551	0	0.0721	0.0061	11.0566
2133 2.3	48.247	N/A	32.864	6.246	0.083	9.5	0	0.353	0.021	97.314	4.9793	N/A	3.9978	0.5391	0.0073	1.4616	0	0.0706	0.0028	11.0585
2133 2.4	48.171	N/A	32.773	6.313	0.081	9.372	0	0.328	0	97.038	4.9854	N/A	3.9979	0.5465	0.0071	1.4459	0	0.0659	0	11.0487
2133 2.5	48.361	N/A	32.909	6.232	0.07	9.312	0.067	0.331	0.024	97.306	4.9895	N/A	4.002	0.5377	0.0061	1.4322	0.0074	0.0663	0.0032	11.0444
2133 3.1	48.207	N/A	32.836	6.128	0.065	9.319	0.028	0.294	0.016	96.893	4.9907	N/A	4.007	0.5305	0.0057	1.4382	0.0032	0.0589	0.0021	11.0363
2133 3.2	48.109	N/A	33.035	6.232	0.073	9.358	0	0.263	0.01	97.08	4.9737	N/A	4.0255	0.5388	0.0064	1.4421	0	0.0527	0.0014	11.0406
2133 3.3	48.176	N/A	32.912	6.278	0.059	9.298	0	0.26	0.005	96.988	4.9849	N/A	4.0141	0.5433	0.0052	1.4342	0	0.0521	0.0007	11.0346
2133 3.4	48.033	N/A	32.959	6.231	0.082	9.288	0.002	0.232	0.109	96.936	4.9757	N/A	4.0243	0.5398	0.0072	1.4343	0.0002	0.0467	0.0144	11.0426
2133 3.5	48.174	N/A	32.898	6.22	0.076	9.374	0.01	0.246	0.025	97.023	4.9829	N/A	4.011	0.5381	0.0067	1.4454	0.0012	0.0493	0.0033	11.0379
2133 4.1	48.42	N/A	32.99	5.968	0.071	9.329	0.018	0.341	0.001	97.138	4.9953	N/A	4.0117	0.5149	0.0062	1.4347	0.002	0.0682	0.0002	11.0332
2133 4.2	48.367	N/A	33.26	6.067	0.053	9.181	0.014	0.368	0.009	97.319	4.9828	N/A	4.0388	0.5227	0.0046	1.4099	0.0016	0.0735	0.0011	11.035
2133 4.3	48.43	N/A	33.012	5.989	0.074	9.17	0.026	0.408	0.023	97.132	4.9984	N/A	4.0159	0.5169	0.0065	1.4108	0.0029	0.0816	0.0031	11.0362
2133 4.4	48.382	N/A	33.252	6.097	0.1	9.15	0.039	0.307	0	97.327	4.9844	N/A	4.0379	0.5253	0.0087	1.4053	0.0043	0.0613	0	11.0273
287-gt2-cd1-1	47.282	0.005	33.456	7.851	0.79	8.138	0.039	0.329	0.04	97.93	4.9061	0.0004	4.0918	0.6813	0.0694	1.2587	0.0043	0.0661	0.0053	11.0834
287-gt2-cd1-2	48.055	0	33.51	7.464	0.738	8.16	0.005	0.29	0.025	98.247	4.9515	0	4.0699	0.6432	0.0644	1.2533	0.0005	0.058	0.0033	11.0441
287-gt2-cd1-3	47.427	0.025	33.25	7.583	0.75	8.067	0.02	0.295	0.016	97.433	4.9346	0.002	4.0778	0.6598	0.0661	1.2513	0.0022	0.0594	0.0021	11.0553
287-gt2-cd1-4	45.12	0.032	31.554	6.969	0.685	7.526	0.018	0.274	0.003	92.181	4.9524	0.0026	4.0823	0.6397	0.0637	1.2314	0.0022	0.0584	0.0004	11.0332
287-gt2-cd1-5	47.827	0	33.386	7.666	0.753	8.136	0.012	0.316	0.028	98.124	4.942	0	4.0663	0.6625	0.0659	1.2533	0.0013	0.0633	0.0037	11.0583
287-gt2-cd2-1	47.627	0.02	33.444	7.713	0.707	7.841	0.053	0.319	0.027	97.751	4.9402	0.0015	4.0888	0.6691	0.0621	1.2124	0.0059	0.0642	0.0036	11.0478
287-gt2-cd2-2	47.817	0	33.556	7.822	0.713	8.062	0.017	0.305	0.02	98.312	4.9338	0	4.081	0.675	0.0623	1.24	0.0018	0.061	0.0026	11.0576
287-gt2-cd2-3	47.539	0	33.321	7.909	0.728	7.941	0.033	0.294	0.009	97.774	4.9353	0	4.0774	0.6867	0.064	1.2288	0.0037	0.0591	0.0012	11.0563
287-gt2-cd2-4	47.811	0	33.32	7.762	0.684	8.103	0.032	0.294	0.047	98.053	4.945	0	4.0621	0.6714	0.06	1.2494	0.0036	0.059	0.0062	11.0568
287-gt2-cd2-5	47.386	0	33.839	7.588	0.711	7.553	0.043	0.287	0.018	97.425	4.9263	0	4.1465	0.6598	0.0626	1.1705	0.0048	0.0578	0.0024	11.0307
287-gt2-cd2-6	48.001	0.007	33.397	7.851	0.716	8.039	0.002	0.309	0.054	98.376	4.9499	0.0005	4.0594	0.6771	0.0625	1.2357	0.0003	0.0618	0.0071	11.0543

NOTE TO USERS

Oversize maps and charts are microfilmed in sections in the following manner:

LEFT TO RIGHT, TOP TO BOTTOM, WITH SMALL OVERLAPS

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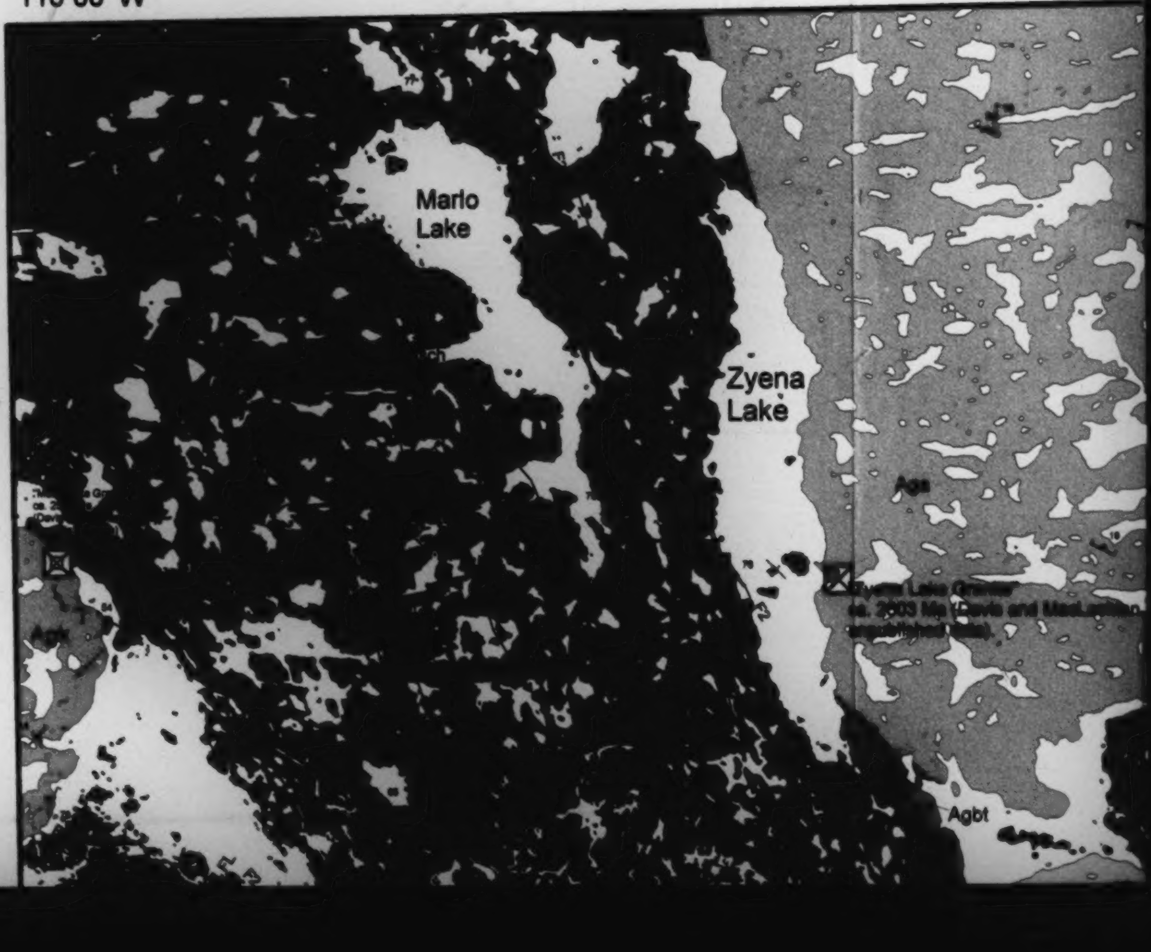
C.S. Lord Northern Geosc
# of the Walmsley Lake Are

Cairns, S.R., MacLachlan, K., Relf

7100000

64°00' N
110°00' W


Marlo
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Zyena
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Ags
Zyena Lake Granite
ca. 2603 Ma (Davis and MacLachlan,
unpublished data).
Agbt
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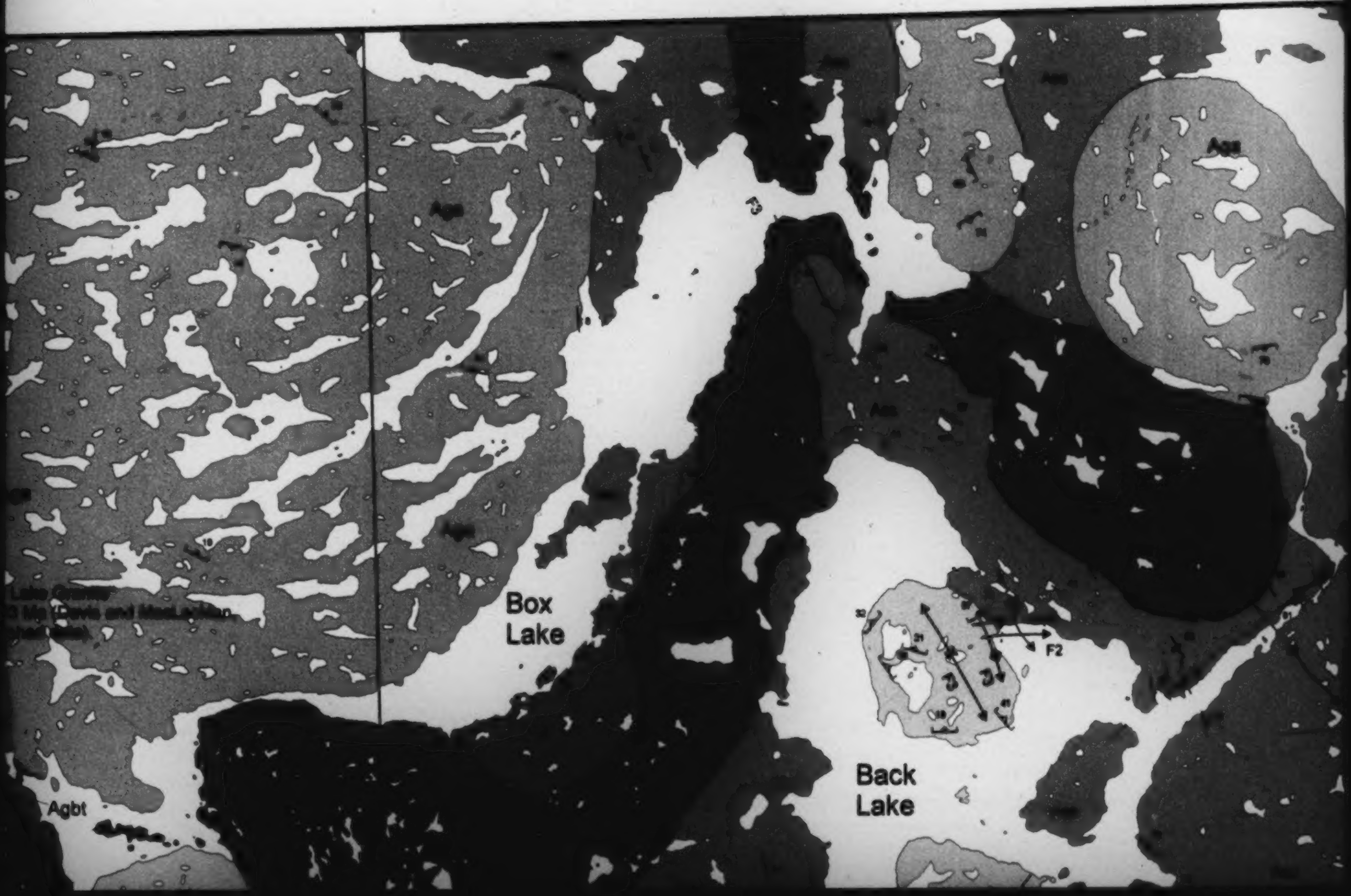
, K., Relf, C., Renaud, J., and Davis, W.


Box
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2003-04. Preliminary Geology Ma

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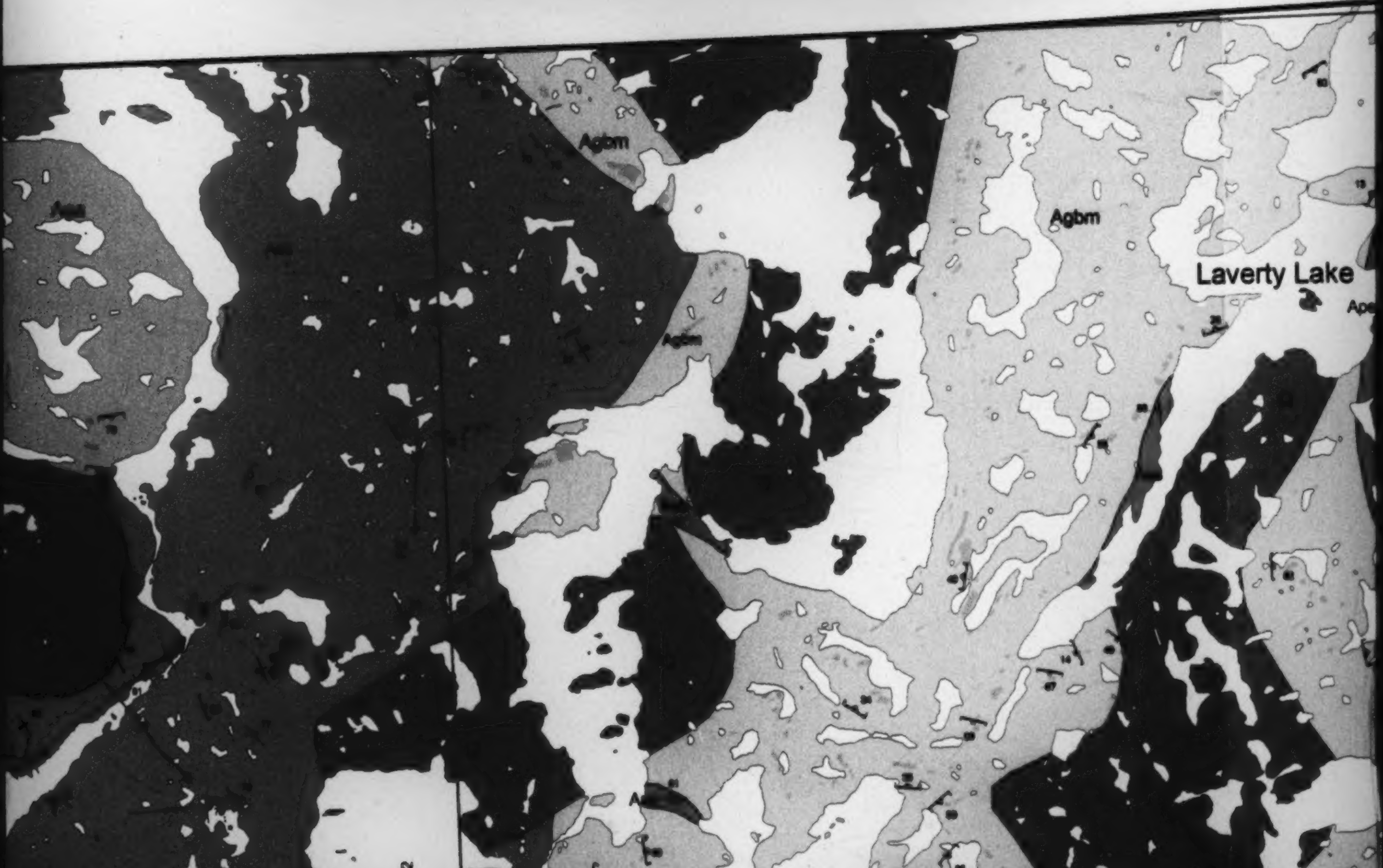
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CANADA
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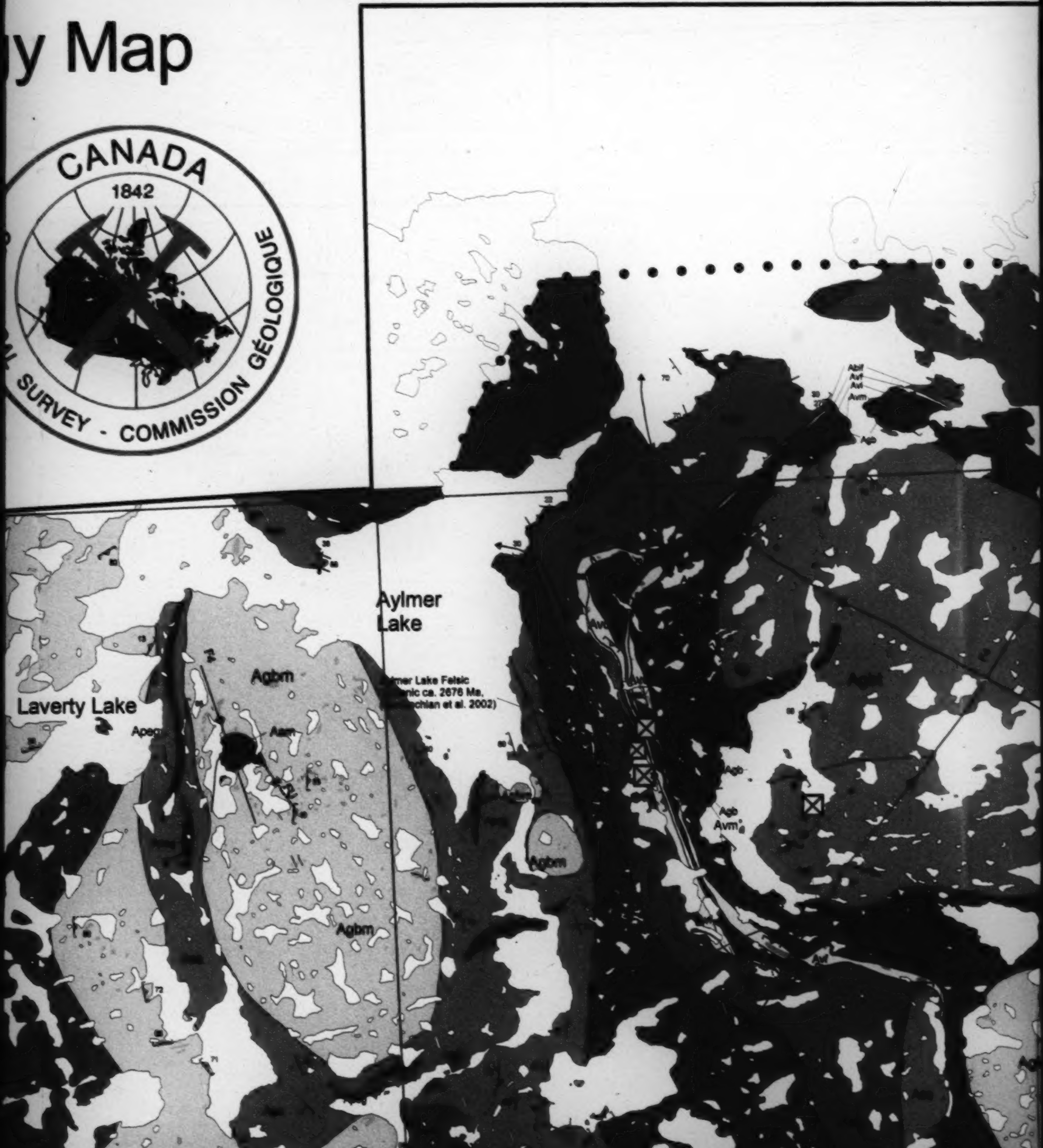
SURVEY - COMMISSION GÉOLOGIQUE


Abif
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nic ca. 2676 Ma.
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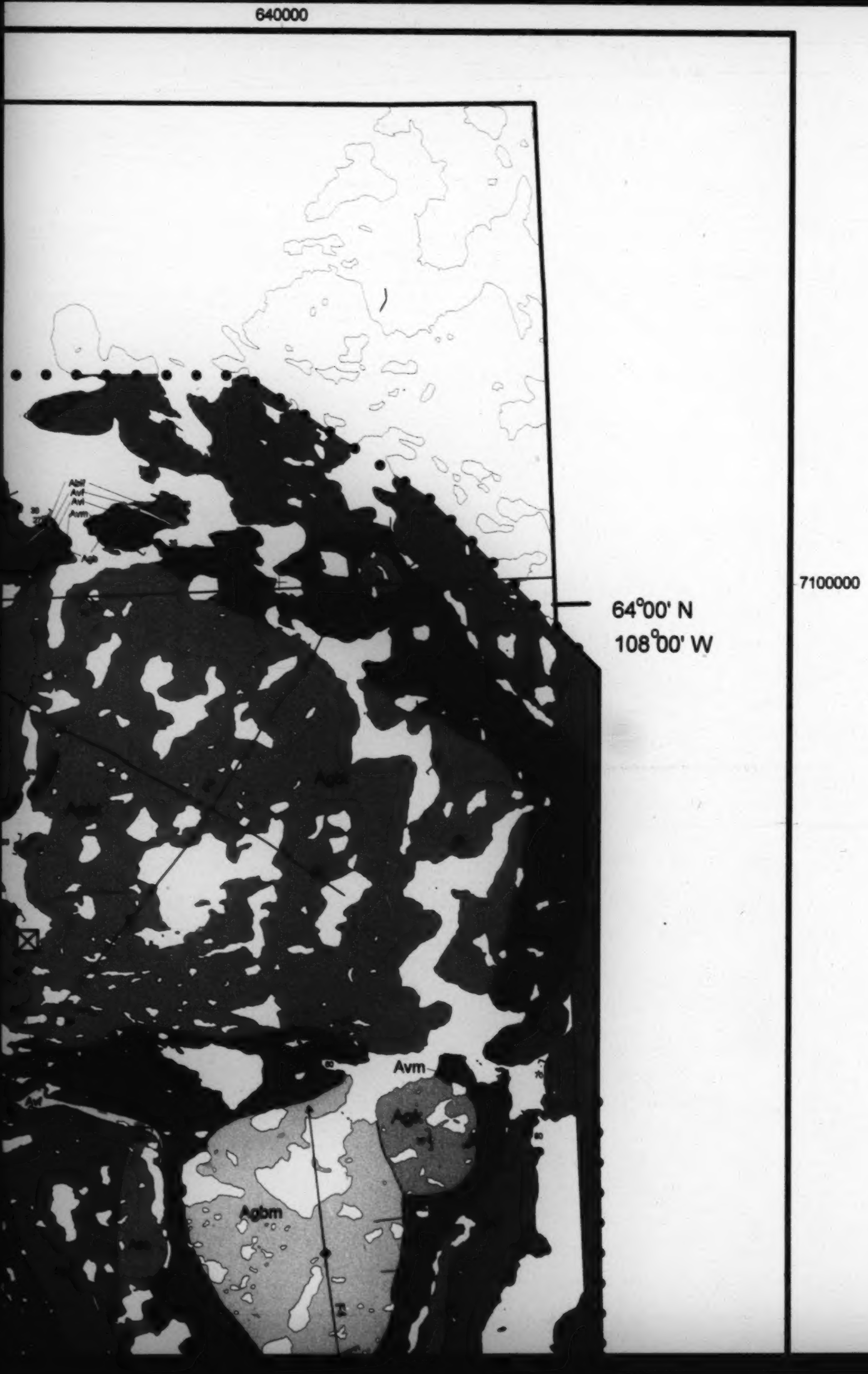
640000
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Agk
Avm
Agk
Agbm

Qua

Prot

Arch

Pluto

Morose

Agk

Agbi

Prospe

Aga

Agbm

Legend

Quaternary

■ Undifferentiated Quaternary cover.

Proterozoic

— Diabase Dykes: Medium-grained, massive, locally brecciated mafic dykes. Correlated by orientation; north-northwest striking, 1.27 Ga Mackenzie swarm (LeCheminant and Heaman, 1989); north-northeast striking 2.02 Ga Lac de Gras swarm (LeCheminant et al., 1996); east-northeast striking 2.23 Ga Mackay swarm (ibid).; north-east striking 2.21 Ga Malley swarm (ibid.). Compositional and textural diversity is present within dykes of similar orientation suggesting other, unrecognized, magmatic events may be present. Width of dykes may be exaggerated on map.

— Lamprophyre Dyke: Fine-grained, massive, brown to grey biotite + clinopyroxene + orthopyroxene porphyritic dike. Contains carbonate occelli and extensive carbonate on fractures. South of Walmsley Lake, width exaggerated.

■ Pyroxenite: Massive, coarse-grained (to 3 centimetres), brown to greenish black pyroxenite. East of Back Lake.

Archean

Plutonic Rocks

■ Granitic pegmatite: Pink to white, with up to 10% muscovite +/- biotite +/- tourmaline +/- garnet +/- apatite, locally contains radiate aggregates of acicular sillimanite crystals up to 10 centimetres long. Generally massive with transitional contacts with Agbm.

Morose-like plutonic rocks

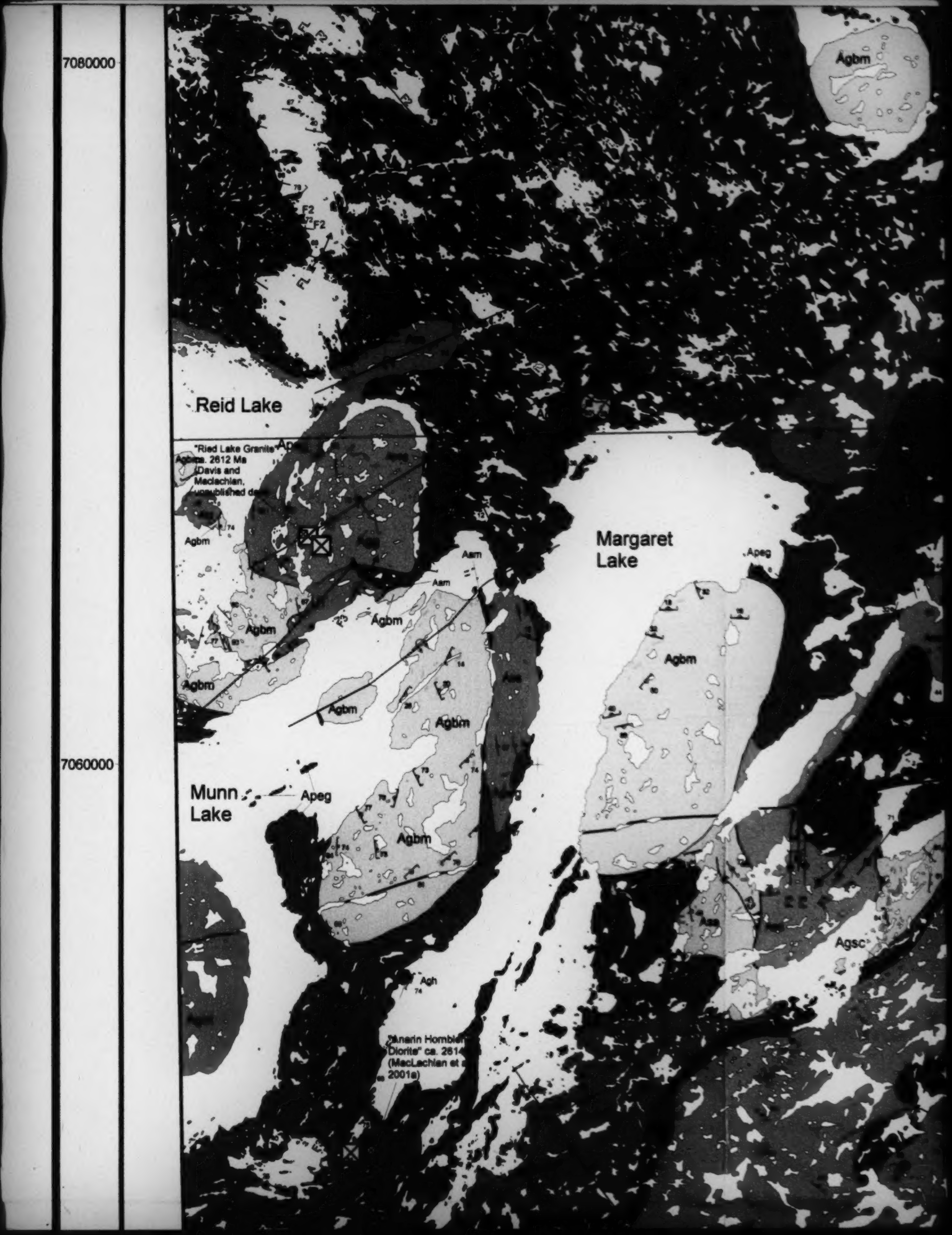
Agk K-feldspar megacrystic granite: Medium-grained, white, massive, biotite-bearing, contains K-feldspar megacrystis up to 7centimetres. Outcrops characterized by subhorizontal and subvertical, metre-scale joints which parallel contacts with surrounding metasedimentary rocks. Includes the ca. 2589 Ma "Marlo Lake granite" (MacLachlan and Davis, unpublished data).

Agbt Biotite monzogranite: Pink weathering, weakly to moderately foliated, medium-grained, locally K-feldspar porphyritic, biotite (<10%) monzogranite. Typically forms tabular intrusions parallel to foliation and depositional layering in host metagreywacke. Locally cuts regional foliation at a high angle. Includes the ca. 2586 Ma "Goodspeed Lake granite" (Davis, Unpublished data)

Prosperous-Like plutonic rocks

Aga Apatite-bearing granite: Fine- to medium-grained leucocratic, white monzogranite with biotite + muscovite (up to 8% combined). Characterized by accessory apatite (greenish blue). Pegmatitic phases contain rare blue lazulite. Ranges from massive to weakly foliated. Includes the ca. 2603 Ma Zyena Lake granite (MacLachlan and Davis, unpublished data).

Agbm Biotite +/- muscovite granite: Massive to moderately foliated, pink to white monzo- to syenogranite with up to 10% combined biotite and muscovite. Characterized locally by accessory apatite (turquoise/greenish blue), garnets (red to purple), and rare lazulite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F2
Reid Lake
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"Ried Lake Granite"
Agbm ca. 2612 Ma
(Davis and
Maclachlan,
unpublished data
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Agbm
Asm
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Lake
Apeg
Agbm
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Agbm
Agbm
Agbm
Agbm
Asa
7060000
Munn
Lake
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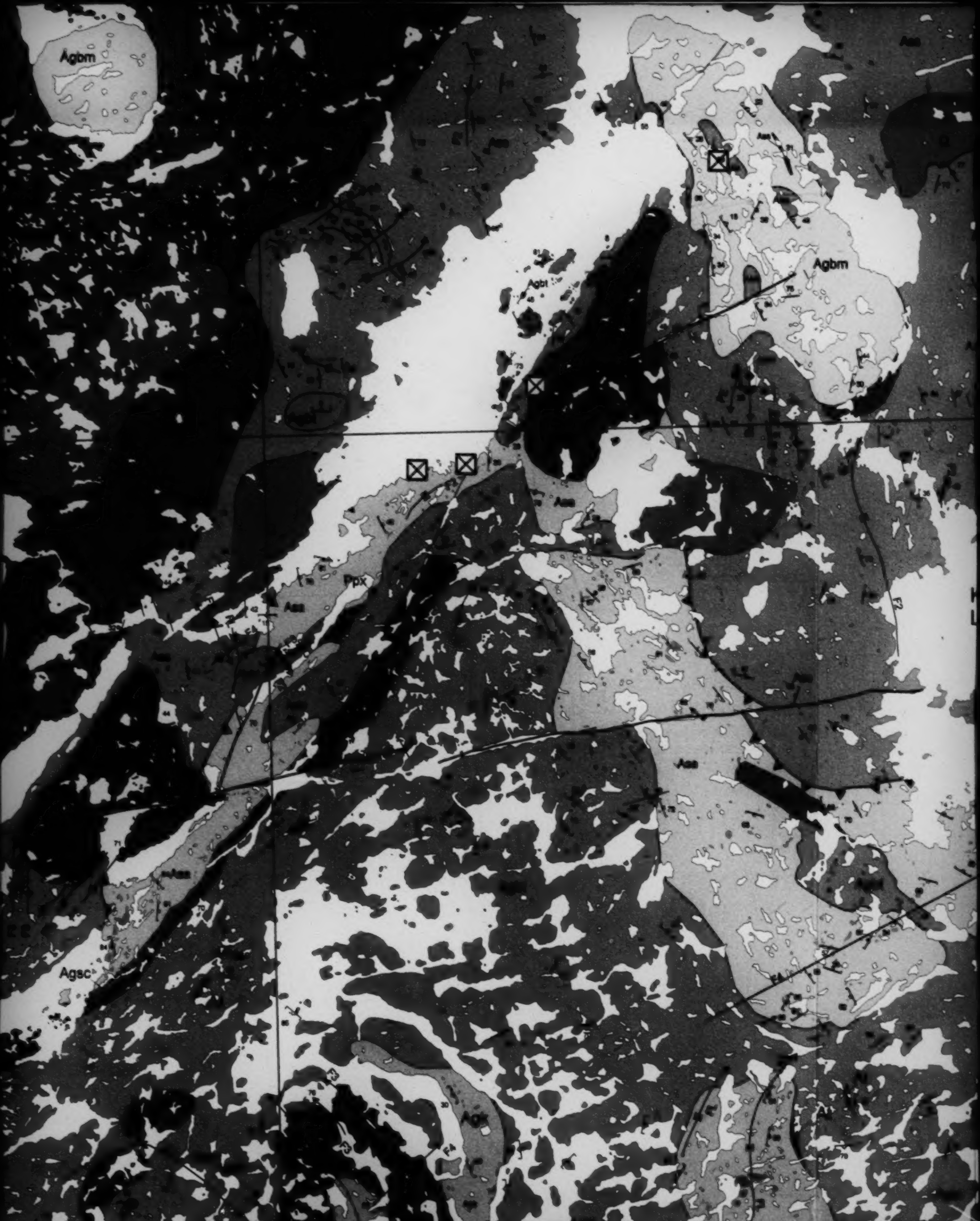
74
"Anerin Hornblende
Diorite" ca. 2614
(MacLachlan et al.
2001a)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Agsc
Agk
Agk
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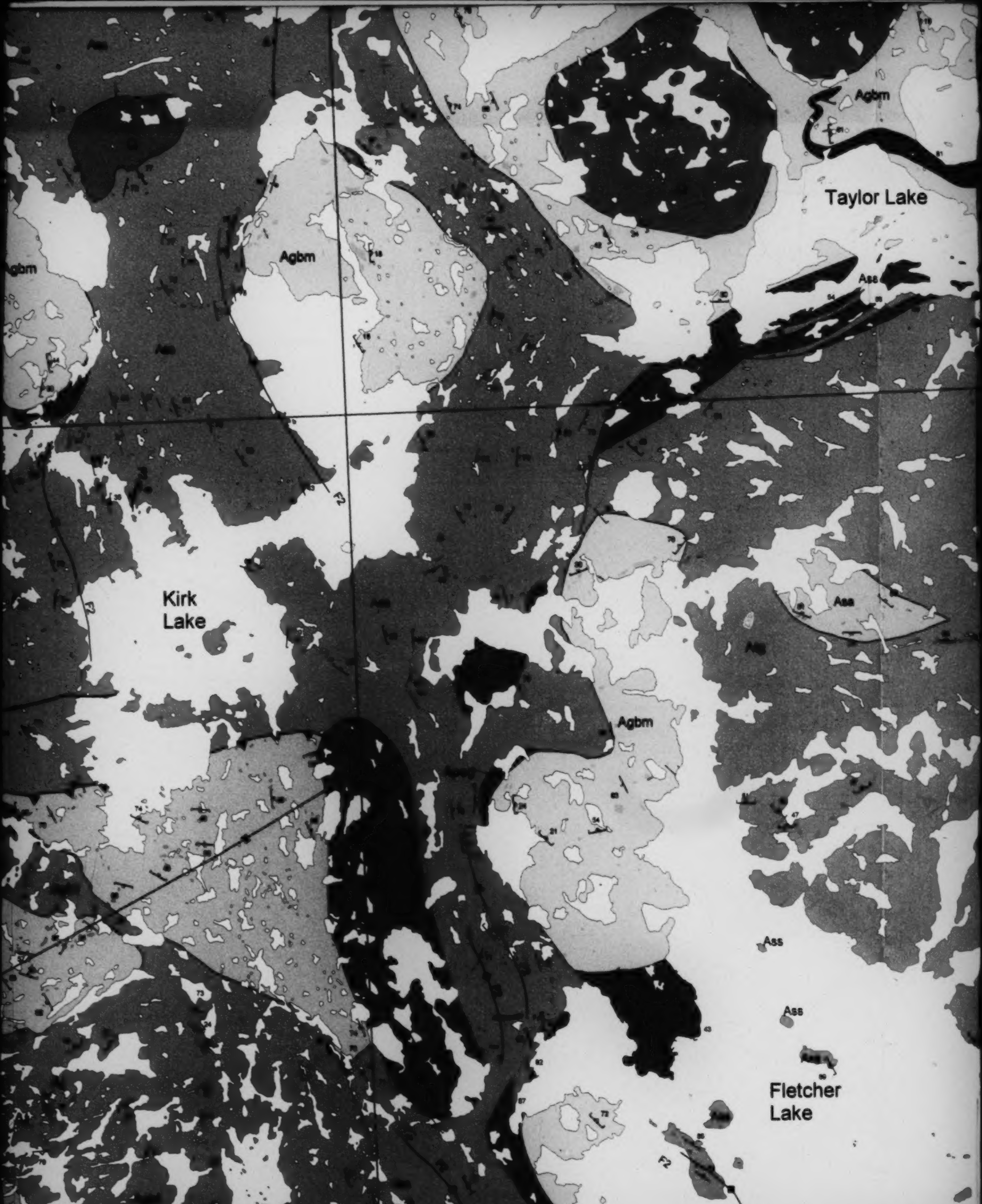
F3
F4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Kirk
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Agbm
Ass
Ass
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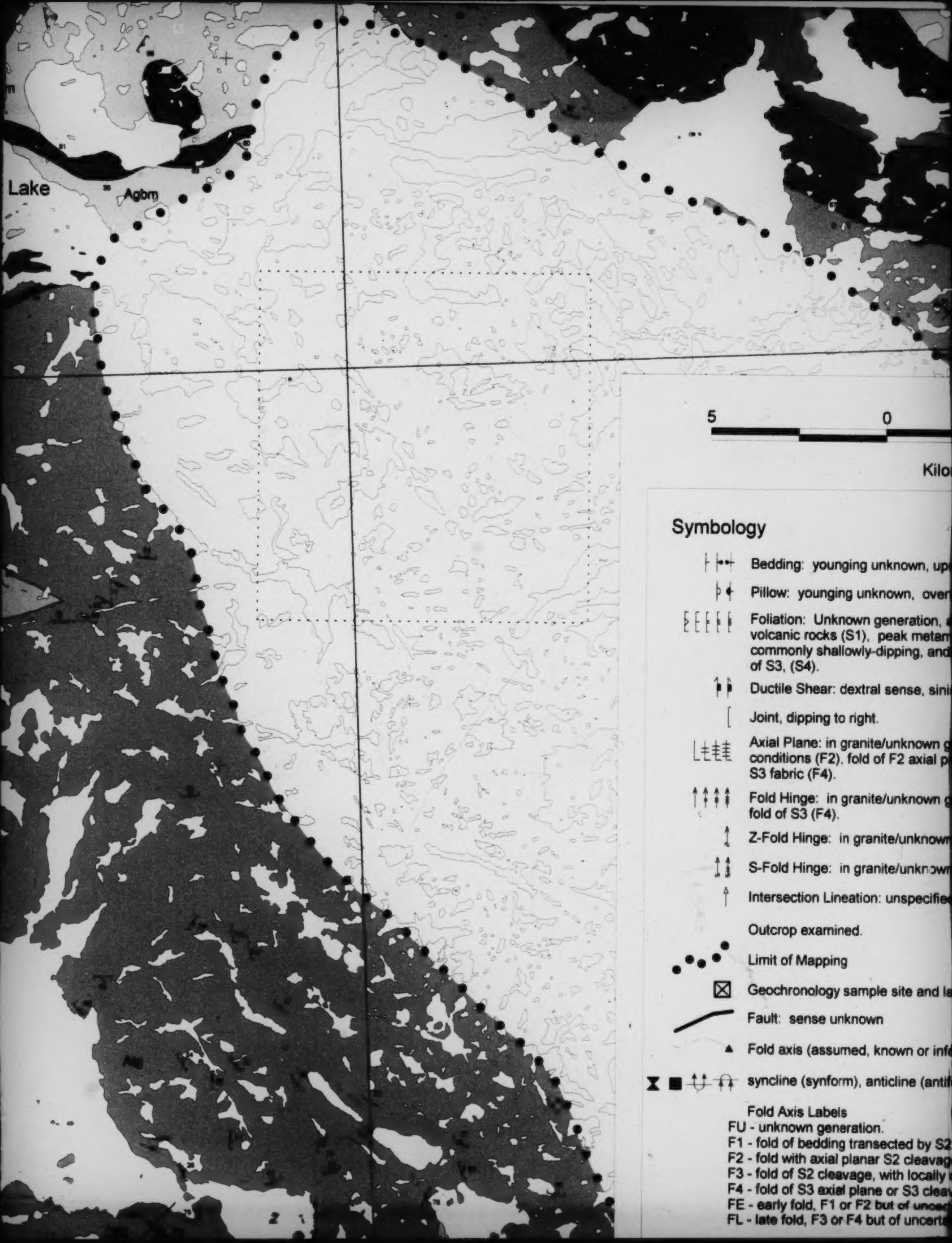
Fletcher
Lake
F2
F2



Symbology

Bedding: younging unknown, up

Pillow: younging unknown, over

Foliation: Unknown generation, a
volcanic rocks (S1), peak metam
commonly shallowly-dipping, and
of S3, (S4).

Ductile Shear: dextral sense, sini

Joint, dipping to right.

Axial Plane: in granite/unknown g
conditions (F2), fold of F2 axial p
S3 fabric (F4).

Fold Hinge: in granite/unknown g
fold of S3 (F4).

Z-Fold Hinge: in granite/unknown

S-Fold Hinge: in granite/unknown

Intersection Lineation: unspecifie

Outcrop examined.

Limit of Mapping

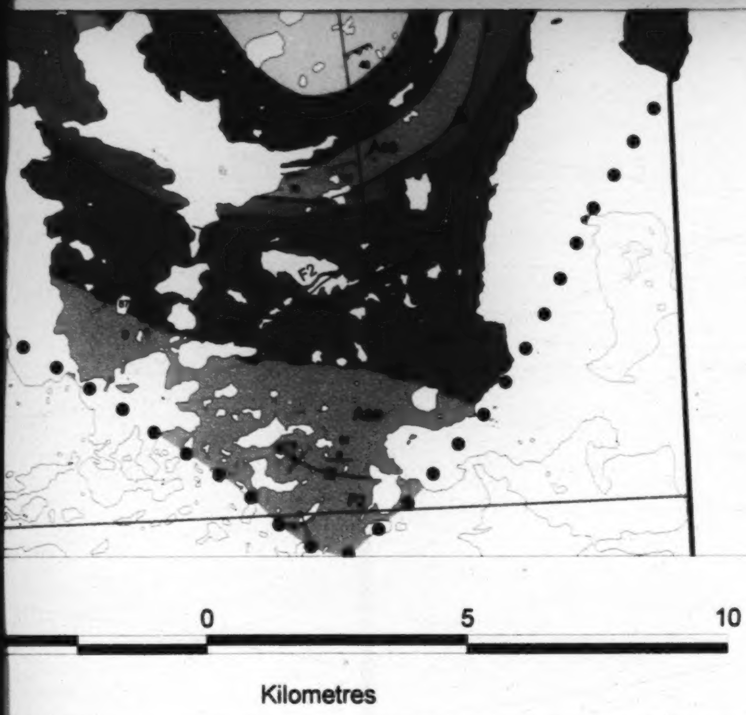
☒ Geochronology sample site and la

Fault: sense unknown

▲ Fold axis (assumed, known or inf

syncline (synform), anticline (antif

Fold Axis Labels
FU - unknown generation.
F1 - fold of bedding transected by S2
F2 - fold with axial planar S2 cleavag
F3 - fold of S2 cleavage, with locally
F4 - fold of S3 axial plane or S3 cleav
FE - early fold, F1 or F2 but of uncer
FL - late fold, F3 or F4 but of uncert



gy

Bedding: younging unknown, upright, overturned

Pillow: younging unknown, overturned

Foliation: Unknown generation, aligned inclusions in porphyroblasts or preserved in volcanic rocks (S1), peak metamorphic minerals in metasedimentary rocks (S2), commonly shallowly-dipping, and/or a crenulation (S3), upright crenulation of S3, (S4).

Ductile Shear: dextral sense, sinistral sense.

Joint, dipping to right.

Axial Plane: in granite/unknown generation (FU), dominant upright fabric below melt-in conditions (F2), fold of F2 axial plane or S2 fabric (F3), fold of F3 axial plane or S3 fabric (F4).

Fold Hinge: in granite/unknown generation (FU), syn-S2 fold (F2), fold of S2 (F3), fold of S3 (F4).

Z-Fold Hinge: in granite/unknown generation, (FU).

S-Fold Hinge: in granite/unknown generation (FU), fold of S2 (F3 or F4).

Intersection Lineation: unspecified generation

Outcrop examined.

Limit of Mapping

Geochronology sample site and label.

Fault: sense unknown

Fold axis (assumed, known or inferred) with plunge direction if known:

syncline (synform), anticline (antiform), overturned antiform, overturned synform.

Fold Axis Labels
- unknown generation.
- fold of bedding transected by S2 cleavage.
- fold with axial planar S2 cleavage.
- fold of S2 cleavage, with locally developed axial planar S3 cleavage.
- fold of S3 axial plane or S3 cleavage.
- early fold, F1 or F2 but of uncertain generation.
- late fold, F3 or F4 but of uncertain generation.

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to syenogranite with up to 10% combined biotite and muscovite. Characterized locally by accessory apatite (turquoise/greenish blue), garnets (red to purple), and rare lazulite (blue), the latter most common in pegmatitic phases. In the northern part of the map area, this unit is commonly mantled by pegmatite. In the central and southern parts of the map area, this unit is characterized by tabular intrusions which parallel S2, and locally transect bedding. Includes "Goodspeed Lake granite" ca 2585 Ma (Davis and Maclachlan, unpublished data)

Agg Garnet-bearing granite: Massive, biotite + muscovite (up to 10% combined), pale pink to white monzogranite with small (up to 1 centimetre) red to purple garnets. Commonly contains screens several metres to 10's of metres thick of metasedimentary rocks. Includes the ca. 2612 Ma Reid Lake granite (MacLachlan and Davis, unpublished data).

Defeat-like plutonic rocks

Atg Tonalite to granodiorite: Medium-grained, multiphase unit, ranging from quartz diorite to granite, but predominantly biotite +/- hornblende tonalite to granodiorite. Cognate enclaves of more mafic material common within felsic phases. Contains a weak to strong, moderate to shallowly-dipping S2 foliation. Contacts with host supracrustal rocks are commonly sheeted parallel to bedding and S2, over 10's of metres.

■ Hornblende Granodiorite: Coarse- to medium-grained biotite, hornblende (up to 5%) monzogranite to granodiorite. Biotite occurs on the margins of horneblende crystal and is of low abundance in the freshest looking areas .

■ Trondhjemite: Coarse- to medium-grained trondhjemite with up to 5 modal percent biotite. Characterized by coarse (up to 1 centimetre), brown to yellow anhedral quartz grains and accessory brown titanite. East of Back Lake.

■ Hornblende tonalite: Leucocratic, fine- to medium-grained, variably deformed, well-foliated biotite +/- hornblende (up to 3%) tonalite to diorite. Commonly forms tabular intrusions, spatially associated with supracrustal lithologies.

■ Diorite: Medium-grained, hornblende +/- biotite-bearing, moderately-to strongly-foliated, diorite to quartz diorite. Includes the "Anarin hornblende diorite", ca. 2614 +5/-2 Ma, (MacLachlan et al. 2001).

Syn-volcanic intrusive rocks

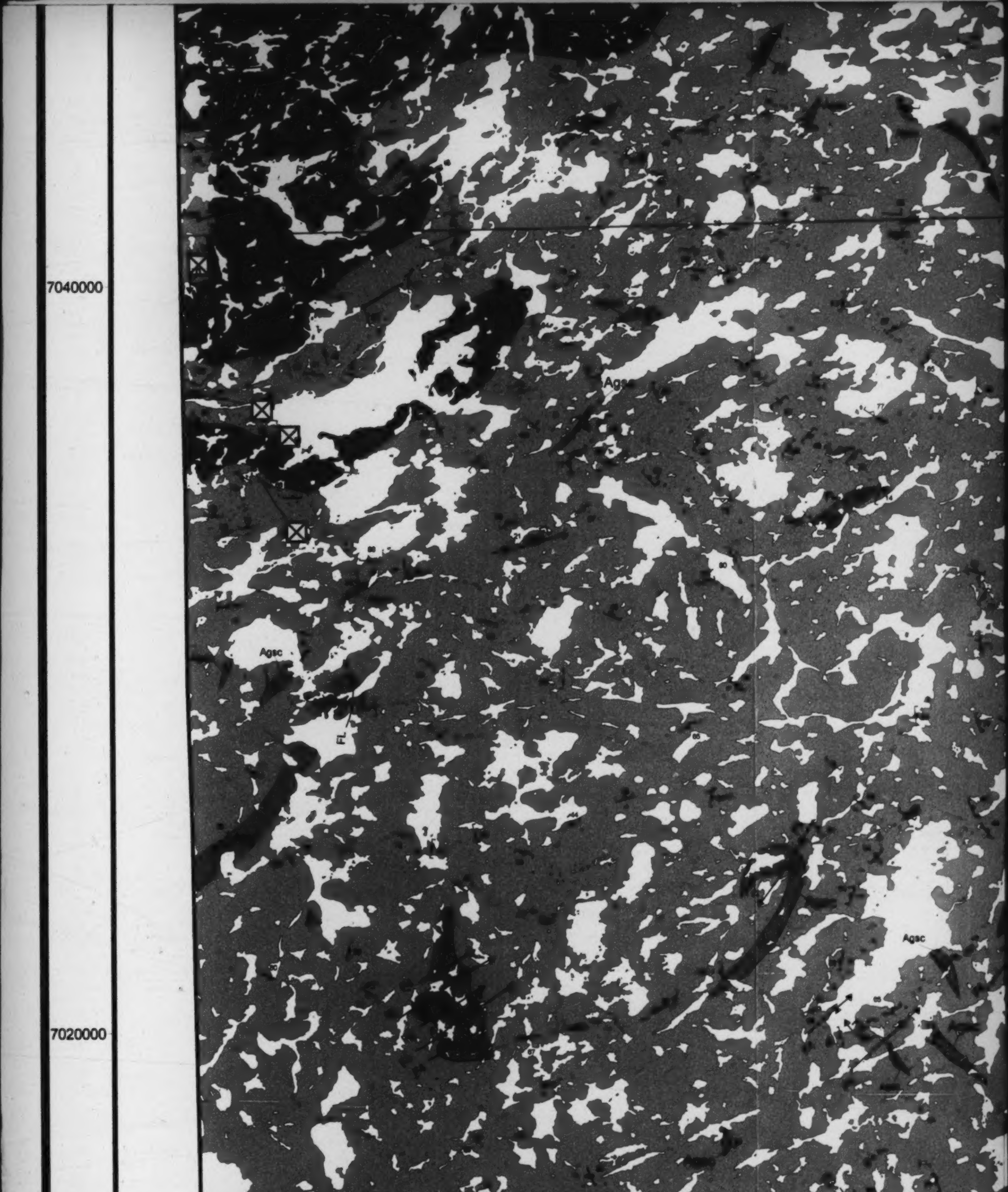
■ Metagabbro sills: Medium- to coarse-grained, hornblende-plagioclase sills with well-developed chill margins against host mafic volcanic rocks. Composition is variable ranging from gabbroic, leucogabbroic, to locally, anorthositic.

■ Gabbro to gabbronorite: Medium- to coarse-grained hornblende gabbro, with subordinate gabbro norite and anorthosite. Plagioclase (labradorite) occurs as subhedral to euhedral crystals up to 7 centimetres in length in coarse-grained domains. Hornblende occurs as small intercumulus crystals, and as large poikiolitic overgrowths on small plagioclase and orthopyroxene crystals. The modal percentage of hornblende varies from 2 to 85%; anorthosite makes up only ca. 5% of the unit. Locally the unit contains up to 5% combined orthopyroxene and clinopyroxene with orthopyroxene > clinopyroxene.

Supracrustal Rocks

■ Injection migmatite: Consists of 20-80% psammitic to pelitic paleosome, layered with granitoid neosome ranging from centimetres to 10's of metres in thickness. Neosome includes biotite +/- hornblende quartz diorite to granodiorite (Agd, Atg), biotite monzogranite (Agbt), and leuco-monzo to syenogranite sheets that parallel compositional layering and foliation (S2). Locally may contain in-situ leucosome.

Asa Anatectic greywacke-mudstone: Partially melted metasedimentary rocks. Leucosome occurs as millimetre or greater scale, foliation-parallel granitic lenses and cross-cutting dykes within sillimanite + biotite +/- muscovite -bearing pelitic layers.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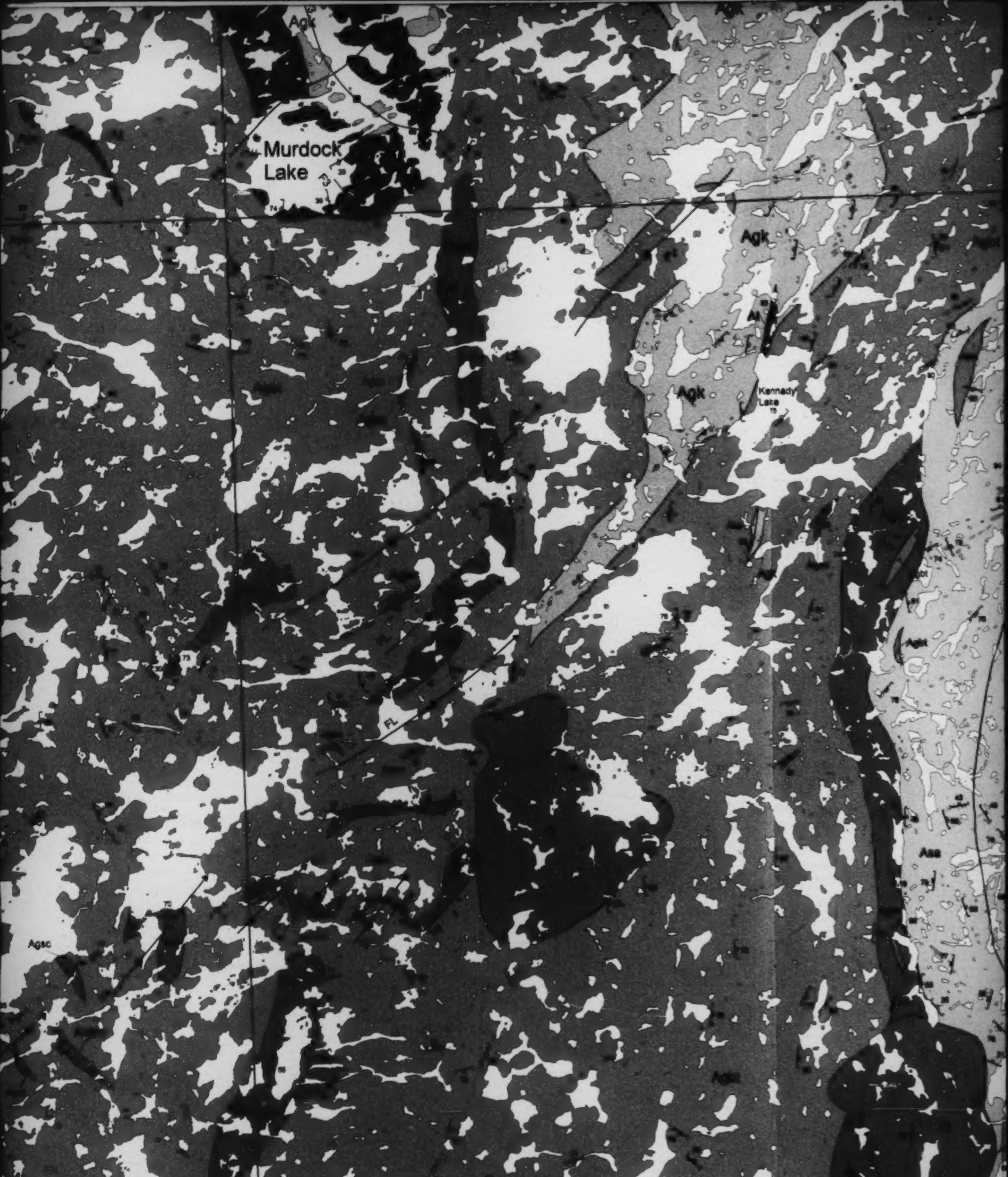
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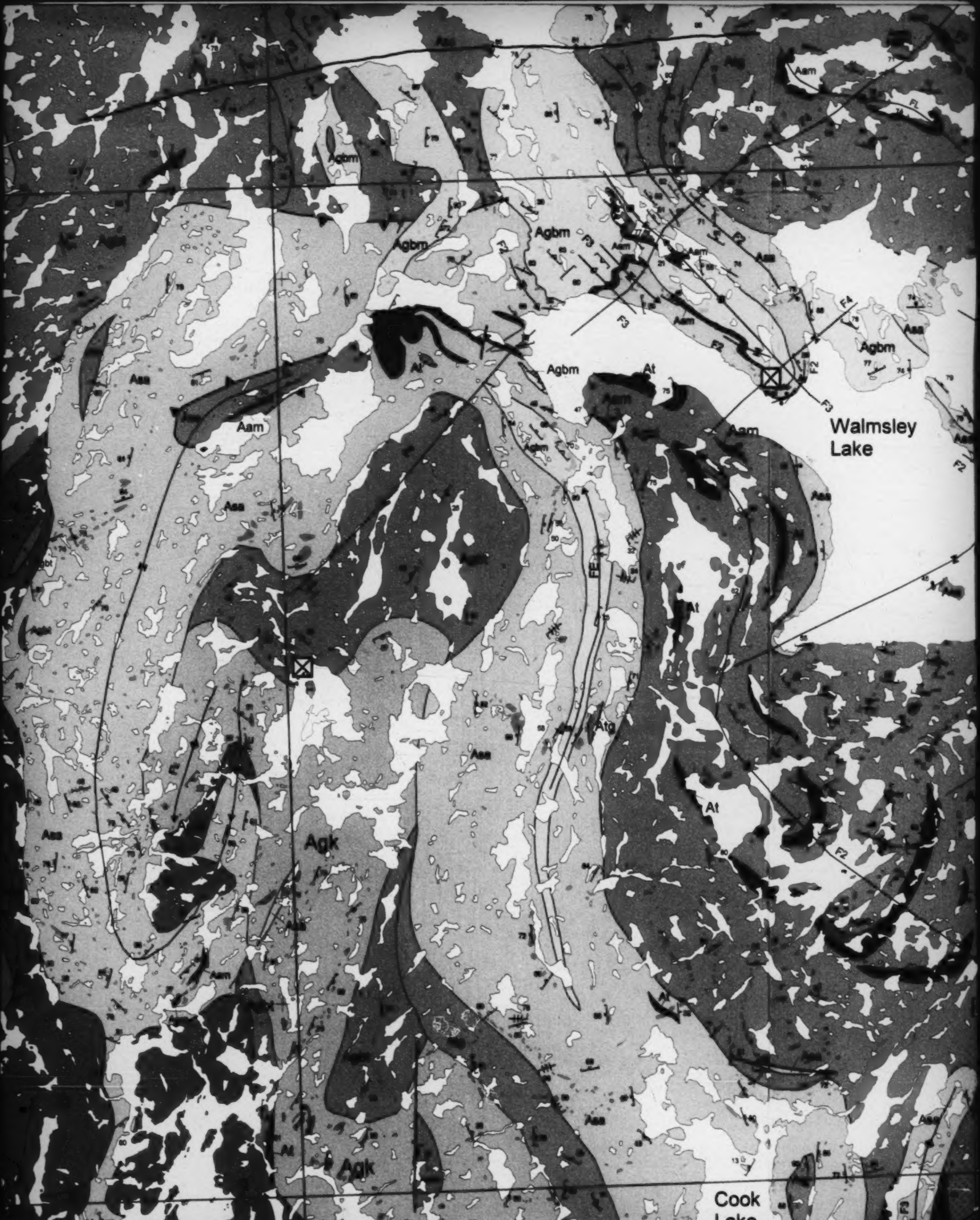

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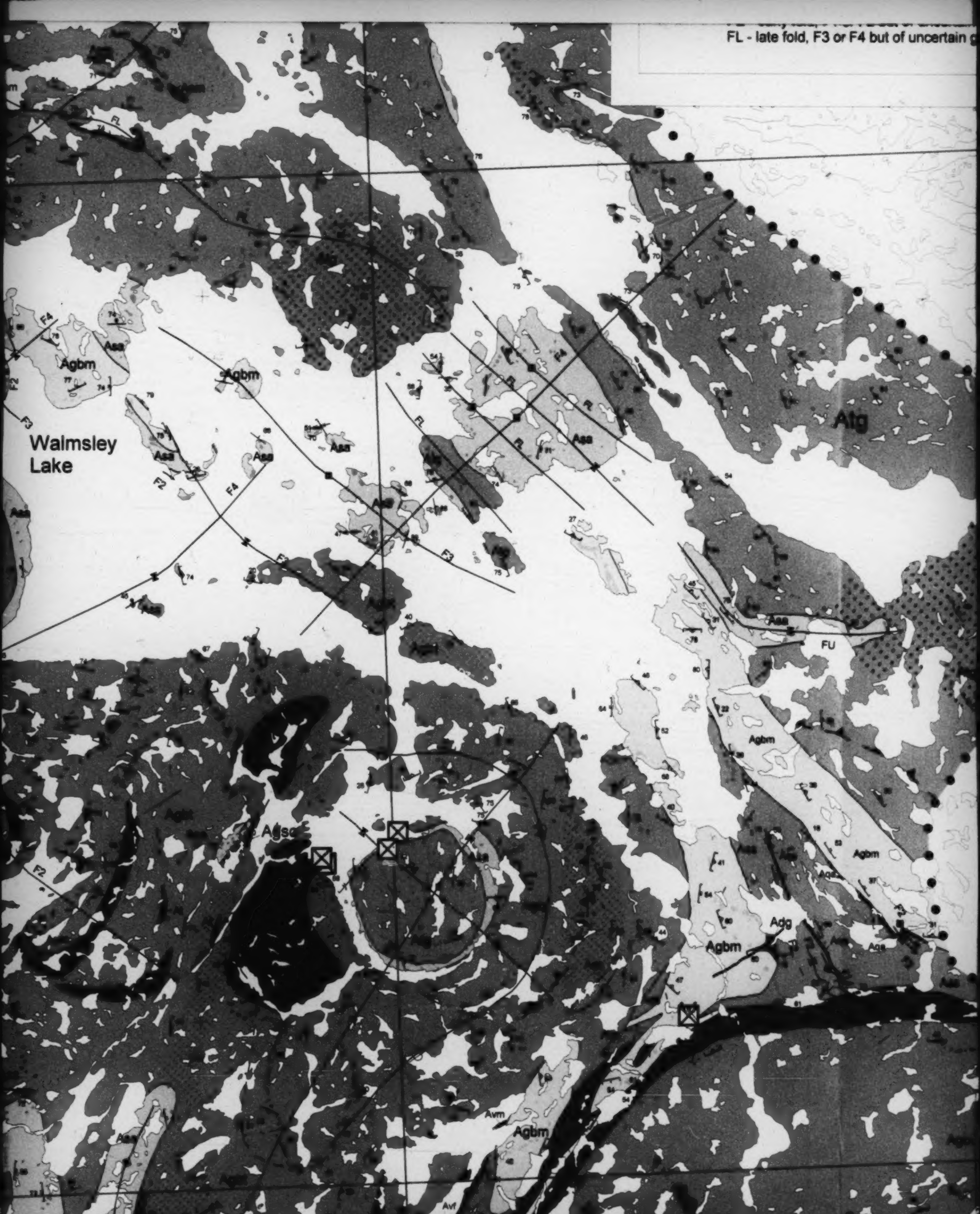
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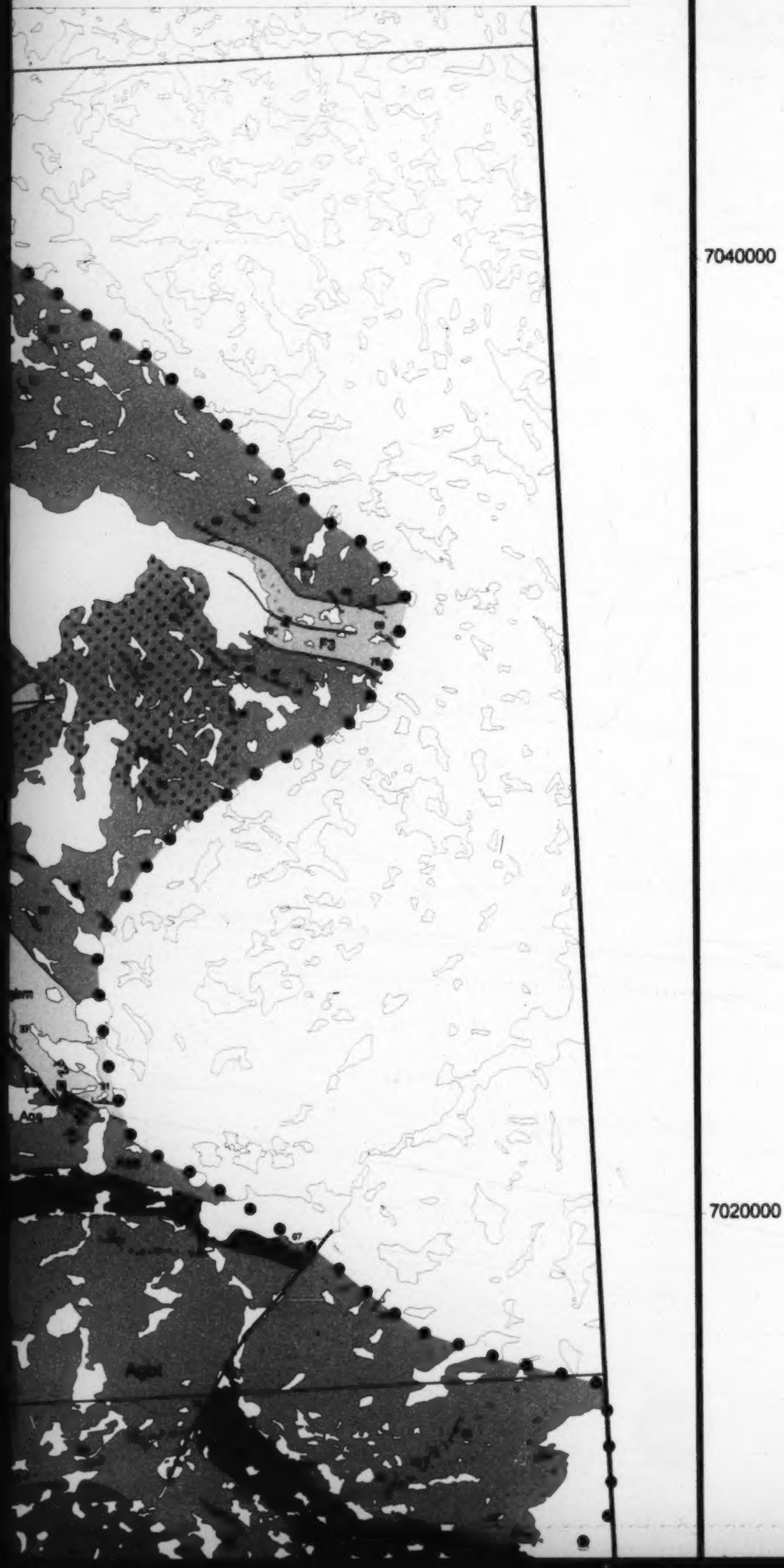
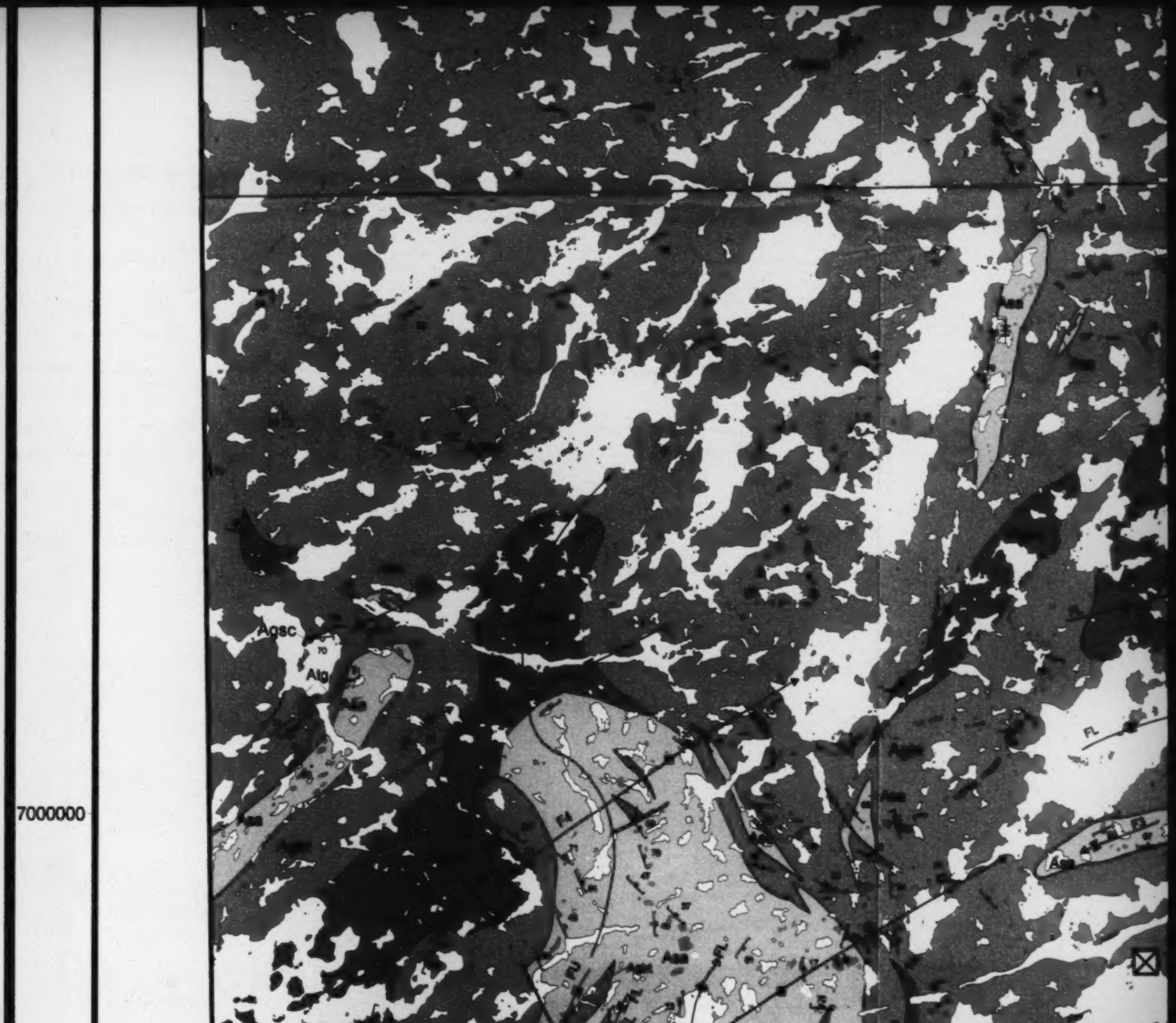


dykes within sillima

Ass	Sillimanite-grade gr features rarely pres aggregates, fibrolite sillimanite-in isogra is typically syn-D2, bedding/S2 interse some late granitic (Cordierite +/- andal
■	Staurolite-bearing g sillimanite schist. A Primary structures, Cordierite porphyro along the bedding/S S2 fabric. Staurolite and garnet are loca
Asc	Cordierite-grade gr in thickness. Prima Cordierite porphyro parallel the bedding S2 fabric. Andalus layers, respectively
■	Biotite-grade greyw metres. Primary fe and rip-up clasts. West of Marlo Lake
■	Chlorite-grade grey metres. Primary fe rip-up clasts. Cont
■	Feldspathic meta-a poorly-sorted, medi grains. Massive fe
■	Banded hornblende metres in thickness (hornblende +/- ga Origin of this unit is with sedimentary r
Avf	Undifferentiated fe Volcanic Belt (AVB lapilli and crystal tu rocks. Silicate faci crystal tuff and rela rhyolite flow (MacL intermediate and fe metres. Contains p brown amphibole (
Ablf	Silicate-sulphide i pyrite iron-formati
Avd	Intermediate volca felsic lapilli tuff and andesitic to dacitic mixed mafic to fels
■	Intermediate volca andesite with inter Andesite variably

	dykes within sillimanite + biotite +/- muscovite -bearing pelitic layers.
Ass	Sillimanite-grade greywacke-mudstone: Psammitic to pelitic, primary sedimentary features rarely preserved. Sillimanite occurs as 3 mm to 1 cm fibrolite aggregates, fibrolite overgrowths on cordierite and andalusite (near the sillimanite-in isograd), or coarse-grained (>1 cm) blades. Bladed sillimanite is typically syn-D2, flattened within the S2 plane or aligned along the bedding/S2 intersection lineation. Dense fibrolite knots occur proximal to some late granitic (Agbm) plutons, and typically overgrow the S2 fabric. Cordierite +/- andalusite +/- garnet are locally present in the sillimanite zone.
[illegible]	Staurolite-bearing greywacke-mudstone: Staurolite, cordierite +/- andalusite +/- sillimanite schist. Assemblage occurs adjacent to volcanic lithologies. Primary structures, such as graded bedding and flames, are locally preserved. Cordierite porphyroblasts range from strongly flattened, within the S2 plane, aligned along the bedding/S2 intersection lineation, or randomly-oriented, overgrowing the S2 fabric. Staurolite porphyroblasts typically overgrow the S2 foliation. Andalusite and garnet are locally present in pelitic and iron-rich psammitic layers, respectively.
Asc	Cordierite-grade greywacke-mudstone: Beds range from tens of centimetres to metres in thickness. Primary structures, such as graded bedding and flames, locally preserved. Cordierite porphyroblasts range from strongly flattened,,within the S2 foliation, aligned parallel the bedding/S2 intersection lineation, or randomly-oriented, overgrowing the S2 fabric. Andalusite and garnet are locally present in pelitic and iron-rich psammitic layers, respectively.
[illegible]	Biotite-grade greywacke-mudstone: Beds range in thickness from millimetres to metres. Primary features include graded bedding, millimetre-scale cross-beds. Flames and rip-up clasts. Contains chlorite + muscovite + biotite porphyroblasts up to 2 mm. West of Marlo Lake.
[illegible]	Chlorite-grade greywacke-mudstone: Beds range in thickness from millimetres to metres. Primary features include graded bedding, millimetre-scale cross-beds, flames, rip-up clasts. Contains assemblage chlorite + muscovite. West of Marlo Lake.
[illegible]	Feldspathic meta-arenite to meta-quartz arenite: White, moderately- to poorly-sorted, medium- to (rarely) coarse-grained, with sub-angular to sub-rounded grains. Massive feldspathic arenite to quartz arenite. Southeast of Walmsley Lake.
[illegible]	Banded hornblende +/- garnet amphibolite: Layering ranges from centimetres to metres in thickness, and is defined by variations in abundance of melanocratic (hornblende +/- garnet) and leucocratic (plagioclase + quartz) minerals. Origin of this unit is unknown, but internal compositional layering and association with sedimentary rocks suggests a supracrustal origin.
Avf	Undifferentiated felsic to intermediate, volcanic and volcaniclastic rocks: Alymer Volcanic Belt (AVB): includes carbonate-bearing, bimodal, fragmental rocks, dacitic lapilli and crystal tuff, rhyolite crystal tuff, and related volcaniclastic sedimentary rocks. Silicate facies iron-formation is locally interbedded within rhyolite crystal tuff and related volcaniclastic metasedimentary rocks. Includes ca. 2676 Ma rhyolite flow (MacLachlan et al., 2002). Cook Volcanic Belt (CVB): Fine-grained intermediate and felsic volcaniclastic rocks, interbedded on a scale of centimetres to metres. Contains plagioclase +/- hornblende +/- garnet +/- biotite +/- quartz +/- pale brown amphibole (anthophyllite?).
Abif	Silicate-sulphide iron formation (AVB only): Two amphibole sulphide-rich, pyrrhotite> pyrite iron-formation.
Avd	Intermediate volcaniclastic rocks (AVB only): Pillowed andesite and mixed mafic to felsic lapilli tuff and volcanoclastic breccia. Cummingtonite-bearing pillowed flows, andesitic to dacitic tuffs and lapilli tuff with biotite bearing fragments. Brecciated coarse mixed mafic to felsic angular fragmental tuffs interpreted as debris flows.
[illegible]	Intermediate volcanic rocks: AVB: Grey-green, fine- to medium-grained pillowed andesite with interstratified 5 to 10 metre thick massive andesite flows. Andesite variably carbonate-altered and locally garnetiferous. CVB: Grey-green,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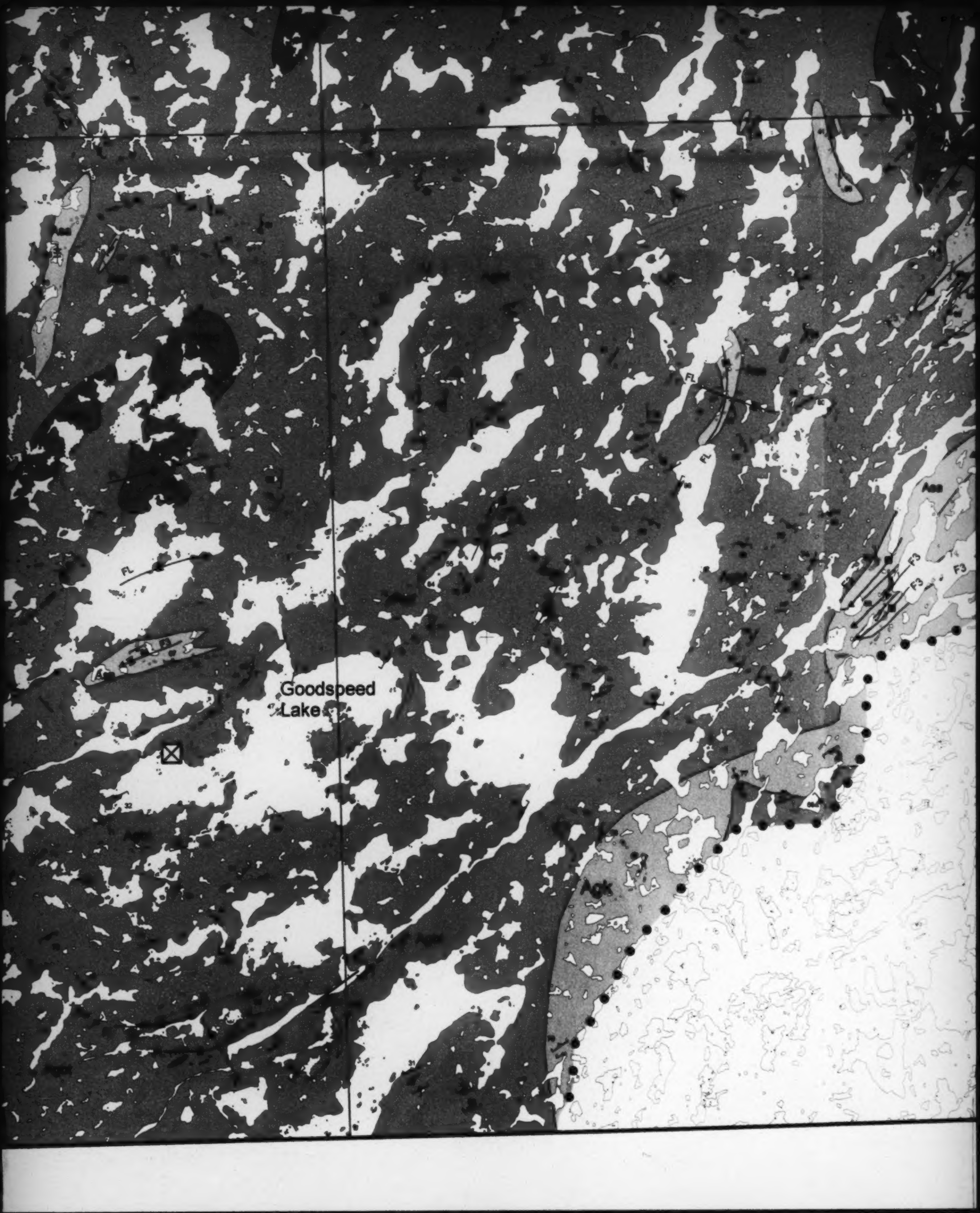
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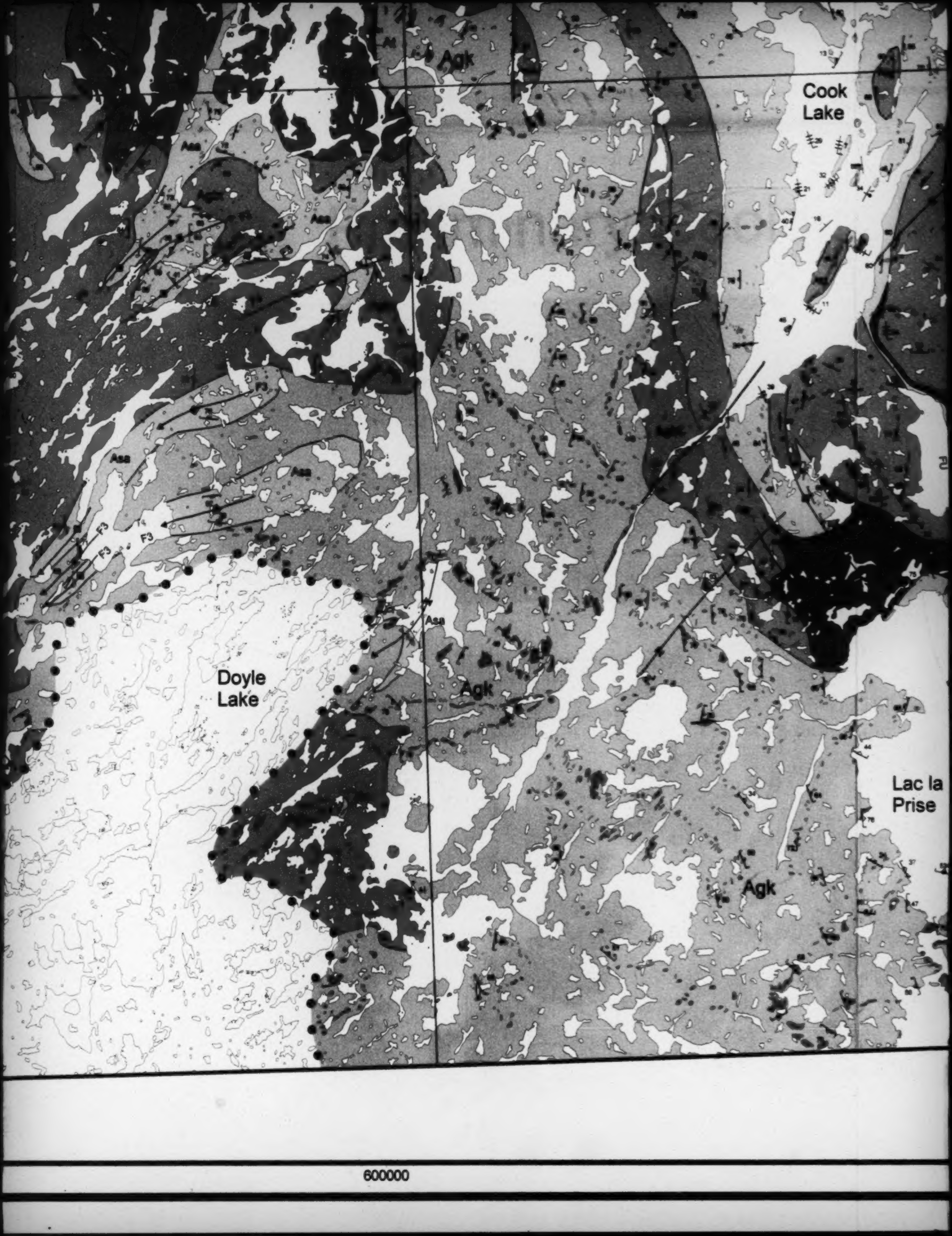
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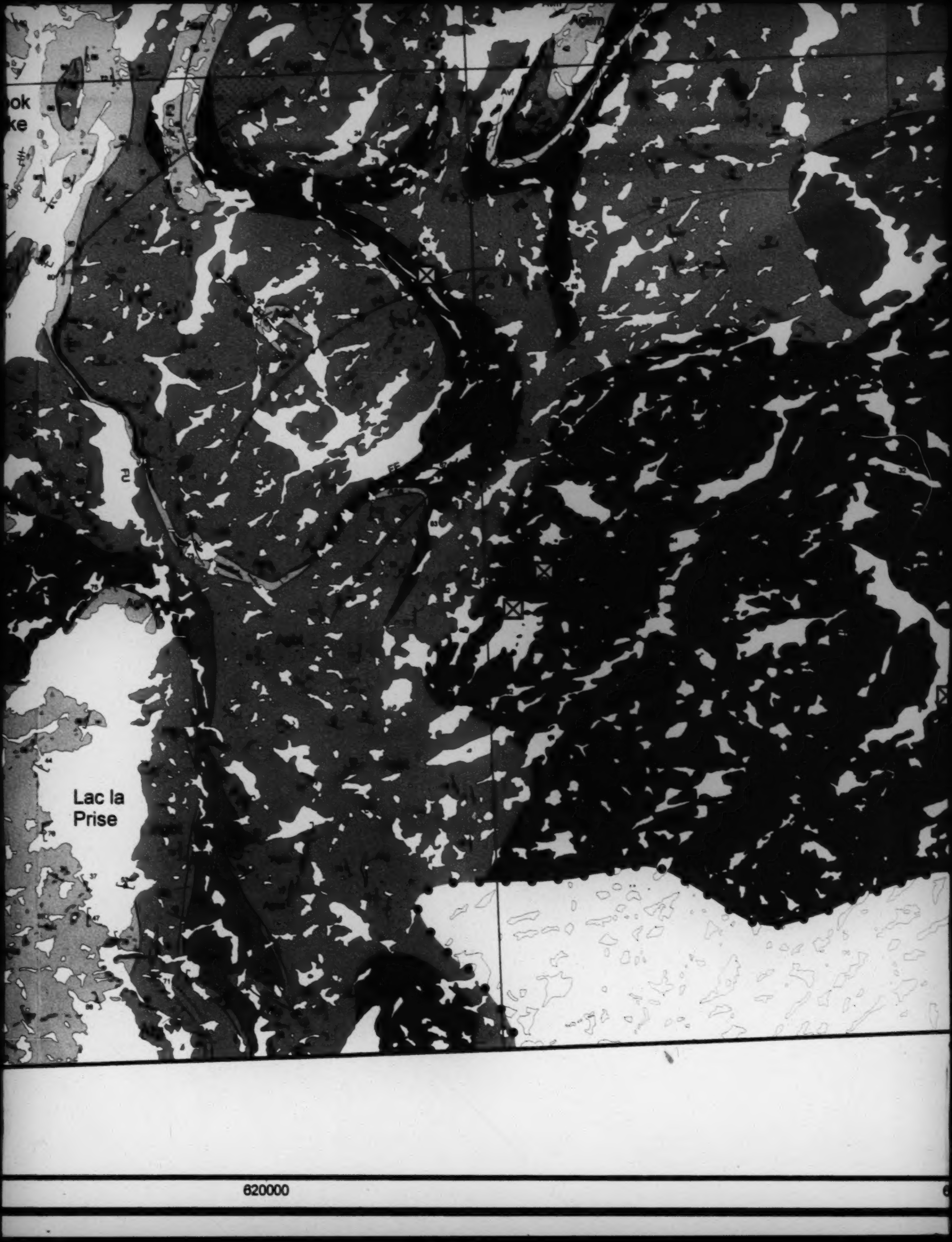
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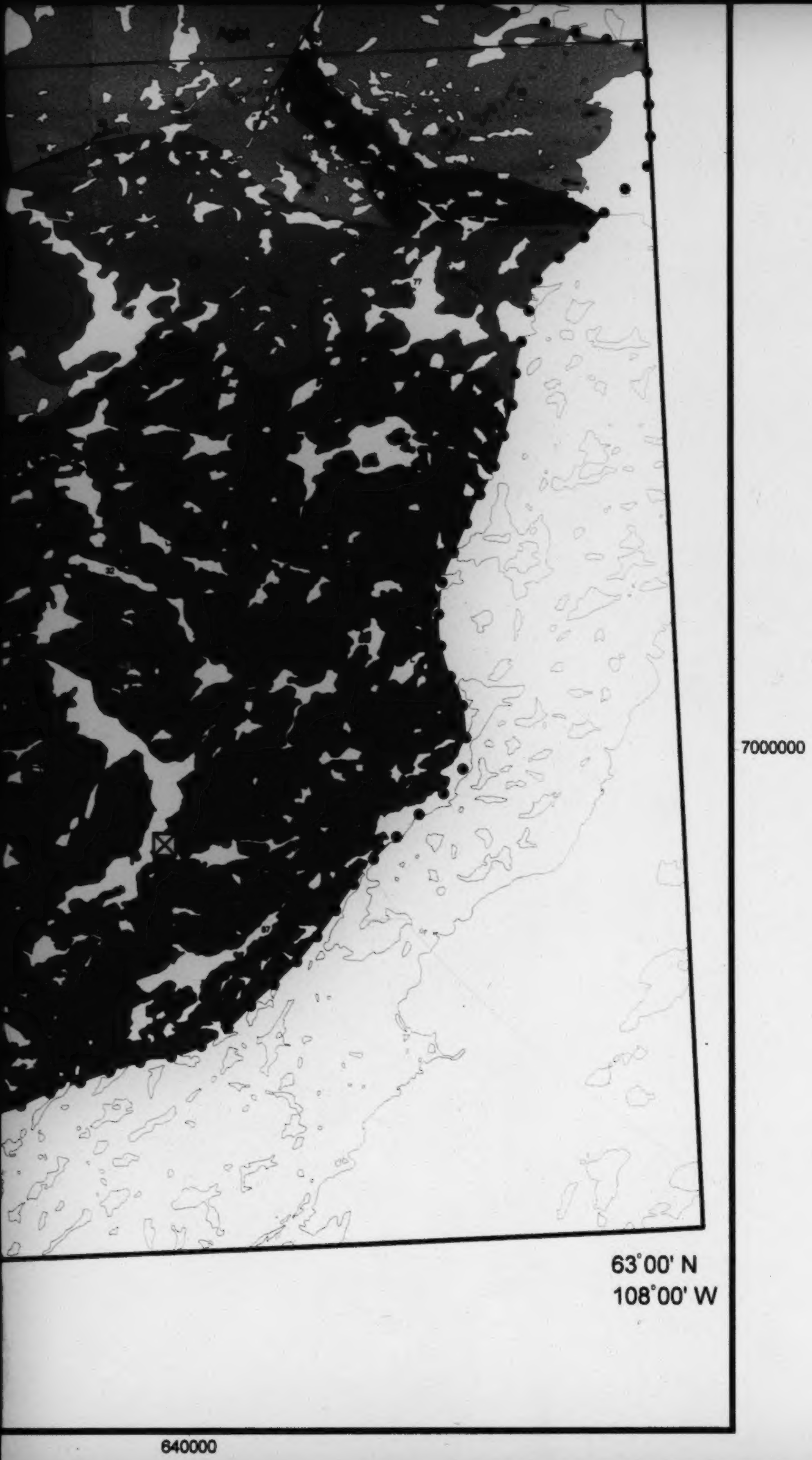

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References

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Avd	Intermediate volcaniclastic rocks (AVB only): Pillowed andesite and mixed mafic to felsic lapilli tuff and volcanoclastic breccia. Cummingtonite-bearing pillowed flows, andesitic to dacitic tuffs and lapilli tuff with biotite bearing fragments. Brecciated coarse mixed mafic to felsic angular fragmental tuffs interpreted as debris flows.
■	Intermediate volcanic rocks: AVB: Grey-green, fine- to medium-grained pillowed andesite with interstratified 5 to 10 metre thick massive andesite flows. Andesite variably carbonate-altered and locally garnetiferous. CVB: Grey-green, fine- to medium-grained pillowed flows interstratified with 5 to 10 metre thick massive units, and well-layered intermediate volcaniclastic horizons.
■	Mafic volcanic rocks: AVB: Variably strained, intercalated pillowed and massive basalt, includes correlative, highly strained, banded-amphibolite. CVB: black weathering, variably strained, pillowed flows with epidote-rich rims and cores, intercalated with dark green to black, fine-grained amphibolite horizons and discontinuously banded rocks interpreted as highly strained pillows. Taylor Volcanic Belt: Variably strained, intercalated pillowed and massive mafic volcanic, includes correlative, highly strained, banded-amphibolite with minor, thin intermediate to felsic composition layers.

Isograds: ornament on high temperature side

⋀⋁	Biotite-in: First appearance of biotite in pelite. West of Marlo Lake.
⋀⋁	Cordierite-in: First appearance of cordierite in pelite.
⋀⋁	Zoned Cordierite: Secondary alteration rims of muscovite and chlorite on cordierite porphyroblasts. West of Zyena Lake.
⋀⋁	Sillimanite-in: First appearance of sillimanite in pelite.
⋀⋁	Melt-in: First appearance of anatectic melt in pelite.
▲	Trace of melt-in isograd through granitoid rocks based on the presence of melt in pelitic enclaves.

Areas with abundant (>15%) supracrustal xenoliths

░	Metasedimentary xenoliths
░	Metasedimentary and amphibolite xenoliths
░	Amphibolite xenoliths

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References

LeCheminant and Heaman, 1989: Ear. Planet. Sci. Let., 96, pp.38-48.
LeCheminant et al., 1996, GSC Open File 3228, pp. 161-169.
MacLachlan et al.,2001: Yellowknife Geoscience Forum Abstract.
MacLachlan et al., 2002: GSC Curr. Res. 2002-C1